

New England Plant Conservation Program  
Conservation and Research Plan

*Carex garberi* Fern.  
Garber's Sedge or Elk Sedge

and

*Triantha glutinosa* (Michx.) Baker  
Sticky False Asphodel

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## SUMMARY

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In New England, *Carex garberi* Fern. and *Triantha (Tofieldia) glutinosa* (Michx.) Baker are limited to the states of Maine, New Hampshire, and Vermont. *Carex garberi*, the rarer of the two species, is ranked as G4 (NatureServe 2001), indicating a taxon that is widespread, but apparently infrequent in portions of its range. In New England, this herbaceous member of the Cyperaceae has been recorded from 35 locations. *Triantha glutinosa* is considered to be globally secure (ranked G5) and has been found at more than 45 locations in New England in similar habitat to *Carex garberi*. Although this taxon appears frequently enough in New England so that it is not considered Regionally Rare, it appears in *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996) as a Division 3 (Locally Rare) taxon because its disjunct populations along the Connecticut River in New Hampshire and Vermont are deserving of conservation.

These two taxa occur on calcareous river shores, ledges, and riverside seeps, often at the same location. Although the substrates that support the two species may differ slightly in parts of their range, both taxa are almost always found in moist seepy areas that are seasonally inundated.

Conservation of *Carex garberi* and *Triantha glutinosa* includes protecting their habitats, maintaining existing soil hydrology, and conserving the flow regimes of the rivers that seasonally inundate the plants.

For both species, conservation also includes maintaining all of the occurrences in the Connecticut River watershed. This includes 11 occurrences of *Carex garberi* and eight occurrences of *Triantha glutinosa*. In this watershed, both taxa are found concurrently at six sites.

Additional conservation objectives for *Carex garberi* also include maintaining nine occurrences along the St. John River in Maine as well as the current number of occurrences along each of the Kennebec (3), the Penobscot (1), and the Aroostook Rivers (2) in Maine -- a total of six current occurrences.

## PREFACE

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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) 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.

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## **INTRODUCTION**

Unlike most NEPCoP Conservation Plans that focus on a single taxon, this plan includes conservation recommendations for two taxa, *Carex garberi* Fern. and *Triantha glutinosa* (Michx.) Baker. These two taxa often grow in similar habitats in New England (primarily calcareous river shores and riverside seeps), often at the same location. Although considering the conservation of both taxa together is logical, the two taxa differ greatly in their rarity within New England. Therefore, the background and status of each taxon will be considered separately in this Plan, but the conservation recommendations are very similar.

In New England, *Carex garberi* and *Triantha glutinosa* are limited to the states of Maine, New Hampshire, and Vermont. *Carex garberi*, the rarer of the two species, is ranked as G4 (NatureServe 2001), indicating a taxon that is widespread, but apparently infrequent in portions of its range. In New England, this member of the Cyperaceae has been known from 35 locations along seepy, calcareous river shores. Based on a global rank at the time of publication (G4T3Q as *Carex garberi* var. *bifaria*) in *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996), it was considered Division 1 (Globally Rare) in New England.

*Triantha* (formerly *Tofieldia*) *glutinosa* is considered to be globally secure (ranked G5) and has been found at over 45 locations in New England in the same habitat, often at the same locations, as *Carex garberi*. Although this taxon appears frequently enough in New England so that it is not considered Regionally Rare, it appears in *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996) as a Division 3 (Locally Rare) taxon because its disjunct populations along the Connecticut River in New Hampshire and Vermont are deserving of conservation concern.

Although the substrates that support the two species may differ slightly in parts of their range, both taxa are almost always found in moist, seepy areas that are seasonally (and in at least one instance, daily), inundated and ice-scoured. Conservation of these two species includes protecting the plants' habitats, maintaining existing soil hydrology, and conserving the flow regimes of the rivers that seasonally inundate the plants.

For both species, conservation also includes maintaining all of the occurrences in the Connecticut River watershed. This includes 11 occurrences of *Carex garberi* and eight occurrences of *Triantha glutinosa*. In this watershed, both taxa are found concurrently at six sites.

Additional conservation objectives for *Carex garberi* also include maintaining nine occurrences along the St. John River in Maine as well as the current number of occurrences along each of the Kennebec (3), the Penobscot (1), the Aroostook Rivers (2) in Maine, comprising a total of six current occurrences.

## I. BACKGROUND FOR *CAREX GARBERI*

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### DESCRIPTION

*Carex garberi* is a loosely caespitose, stoloniferous, herbaceous perennial that can grow to 6 dm in height. The leafy tufts are often fibrillose at the base, and the leaves are slender, 1-5 mm broad, and often green-glaucous. The leaves may be shorter or extend beyond the inflorescence. The flowering culms are stiff and erect to flexuose and arching. The bracts are foliaceous, not auricled, the lower (and often others) much exceeding the inflorescence. The 3-7 spikelets are densely cylindric; the upper are crowded, the lower are distant. The terminal spike is usually gynecandrous (staminate usually only at the base), and 0.8-3 cm long. The lateral spikes are dense with middle internodes 0.2-0.7 mm; the basal spikes sometimes occur on long pedicels. The pistillate scales, which are shorter (about  $\frac{3}{4}$  the length) than the ellipsoid to ovoid perigynia, are membraceous, broadly oblong to ovate, brown to purplish (rarely green), and rounded at the tip, acute, or barely mucronate. The perigynia are plump and convex, dry and white-papillate, 2-3 mm long with rounded beakless summits (Fernald 1935, Fernald 1950, Voss 1972).

### TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

*Carex garberi* Fern. (Cyperaceae) was first described by Fernald in *Rhodora* (Fernald 1935). The taxon was originally cited in 1871 as *Carex aurea* var. *androgyna* Olney from a specimen collected in Erie County, Pennsylvania and was later treated as *Carex bicolor* in *Gray's Manual* in 1908. Separating *C. garberi* from *C. bicolor* and *C. aurea*, Fernald's (1935) treatment also described a new variety, *Carex garberi* var. *bifaria*. According to Fernald, *C. garberi* var. *bifaria* is a smaller representative located along rivers and shores from Gaspé County, Quebec to northern New England, west to the Great Lakes and disjunct in the Canadian Rockies. *Carex garberi* proper -- a larger, more robust plant -- was found on the shores of the great Lakes from Niagara to the head of Lake Michigan and the north shore of Lake Superior. Hulten (1968) changed the status of the variety to subspecies: *C. garberi* ssp. *bifaria* (Fern.) Hulten. Current research places var. *bifaria* and subspecies *bifaria* in synonymy under *C. garberi* (Peter Ball, contributor to *Flora of North America*, personal communication; Haines and Vining 1998) but the varietal name is still used by agencies in some New England states (New Hampshire Natural Heritage Inventory 2001).

*Carex garberi* is placed in section *Bicolores* in most references, but in the upcoming edition of the Cyperaceae in *Flora North America*, it will be placed in section *Racemosae* (Arthur Haines, New England Wild Flower Society, personal communication). It has been confused with a number of other taxa including *Carex aurea*, *Carex bicolor*, and *Carex hassei*. Two taxa, *Carex hassei* and *Carex bicolor*, can

be easily separated from *C. garberi* by geographic range alone. *Carex hassei* occurs along the west coast of North America from southern California to British Columbia, extending inland to Nevada, Utah, and Arizona. *Carex bicolor*, primarily an Arctic species, occurs from Alaska through the northern sections of the Canadian provinces to eastern North America and is also found in Europe and Asia (Peter Ball, personal communication). The ranges of *C. hassei* and *C. bicolor* do overlap with that of *C. garberi* and in the west, but neither *C. hassei* or *C. bicolor* are thought to exist in New England (Peter Ball, personal communication).

*Carex garberi* ranges from Alaska, Saskatchewan, and Manitoba to Quebec and New Brunswick at the northern edge of its range. Its range does extend southward into California and Oregon, but the southern edge of its range is located primarily from North Dakota east to Illinois and Indiana and northeastward to Pennsylvania (NatureServe 2001). In New England, *C. garberi* is limited to the states of Maine, New Hampshire, and Vermont, but it also occurs in New York State.

The fourth taxon in the complex, *Carex aurea*, is sympatric in much of its range with *Carex garberi*. *Carex aurea* ranges from Alaska to Newfoundland south to Pennsylvania northern Indiana, westward to Minnesota, Nebraska, New Mexico, and California (Gleason and Cronquist 1991). For several reasons, the two taxa have been confused. They may occupy similar habitats in some areas, and dried herbarium specimens of the two species can be easily confused. In fact, Cronquist (Gleason and Cronquist 1991) lists *C. garberi* and *C. hassei* under *C. aurea*.

Several characters are used to separate *C. garberi* and *C. aurea*. With fresh material, the perigynia of *C. aurea* are orange when fully mature (as opposed to the white-papillose mature perigynia of *C. garberi*), but the perigynia on dry or immature material of *C. aurea* may be difficult to distinguish from those of *C. garberi*, and a few collections are quite intermediate (Voss 1972). According to Elizabeth Thompson (The Nature Conservancy) in a 1996 memorandum to the New England Plant Conservation Program (NEPCoP), the change in color of the perigynia means that herbarium material may be difficult to identify, and “is not as useful in this complex as it is with other material.”

The pistillate spikes of *C. garberi* are also denser than those of *C. aurea*. Dr. Peter Ball (email to Arthur Haines) suggests that internode length in the pistillate spikes is a moderately good character for separating the two taxa, but that this character can be quite variable depending on position in the spike. The internode between the lowest perigynia and the middle perigynia on the lower spikes (not the basal spike) should be used for identification.

The terminal spike on the two species, while somewhat diagnostic, has also led to some confusion. In *C. aurea*, the terminal spike is usually entirely staminate, while in *C. garberi*, it is usually gynecandrous. Arthur Haines has seen populations where only 50% of the plants of *C. garberi* have a gynecandrous terminal spike, and at least one population along the Connecticut River in Vermont also contains plants with staminate

terminal spikes (personal observation). Dr. Peter Ball says that 50 % gynandrous terminal spikes is a very low percentage for a population of *C. garberi*. He allows that one can find odd individuals with a staminate terminal spike, but that these often seem to be plants in which the terminal flowers are sterile. According to Dr. Ball, sex in the terminal spike may be a plastic character. He suggests staminate spike thickness as a useful character, although some overlap exists in this character exists between the two taxa.

Dr. Anton Reznicek (University of Michigan, personal communication) agrees that although terminal spike characteristics are fairly strong tendencies, they are by no means infallible attributes. Dr. Reznicek allows that *C. aurea* has mostly staminate terminal spikelets, but occasionally the spikelets are gynecandrous. Conversely, according to him, some entire populations of *C. garberi* have mostly staminate terminal spikes, but that some gynecandrous terminal spikelets can also usually be found. To Reznicek, however, it would be unusual not to find any gynecandrous terminal spikelets in a population of *C. garberi*, unless perhaps the few specimens all consist of just one culm, which is not a good sample.

Other characters may also be used to separate the two taxa. Reznicek also suggests that the papillae on the spike rachis and peduncle is a useful character. *Carex garberi* is finely papillose, while *C. aurea* is basically smooth. The pistillate scales of *C. garberi* tend to be dark brown and blunt, while those of *C. aurea* tend to be a lighter brown and pointed (Haines and Vining 1998).

Dr. Ball suggests that no single character separates the two taxa, but that a combination of characters can usually clearly distinguish them, at least in eastern North America. To confuse the issue further, Dr. Ball has also seen orange perigynia on *C. garberi*, and he also believes that hybrid populations between the two sometimes occur, with the hybrids fertile. Reznicek has not seen any hybrids, but would expect hybrids to show some sterility. The following chart lists the major characteristics separating the two taxa.

<b>Taxon</b>	<b>Terminal Spike, Thickness</b>	<b>Lateral Spike Internodes</b>	<b>Perigynia</b>	<b>Pistillate scales</b>	<b>Rachis and peduncle</b>
<i>Carex aurea</i>	Usually staminate, < 1.5 mm wide	Internodes (0.5) 0.7 - 1.5 mm or greater	Orange when mature, brown when dried	Tend to be acute or pointed and light colored	Usually smooth
<i>Carex garberi</i>	Usually gynecandrous, >2 mm. wide	Internodes 0.2 - 0.7 mm	Usually white to light brown when mature	Tend to be obtuse or blunt and dark	Papillose

The conclusion reached by Thompson in a 1996 memorandum to NEPCoP's Vermont Task Force is that there are two distinct entities in New England with a distinct habitat preference and morphology. *Carex aurea* has bright-orange, swollen perigynia at maturity and is something of a habitat generalist. *Carex garberi* is quite specific to open

calcareous shores and does not have bright-orange perigynia (although they may be more of a burnt orange).

The above discussion raises the issue of whether occurrences of *C. garberi* in New England are correctly identified. In spite of past (and potentially future) confusion between *C. garberi* and *C. aurea*, the Element Occurrences (EOs) of *Carex garberi* in New England are based upon 15 years of collective observations of botanists that are thoroughly familiar with the taxon in this region including Tom Rawinski, Bob Popp, Dan Sperduto, Arthur Gilman, Susan Gawler, Arthur Haines, Sally Rooney, Josh Royte, Elizabeth Thompson, and Jill Weber. The experience of these botanists, coupled with the distinct habitat preference of *C. garberi* in New England, leads to the conclusion that occurrences of *C. garberi* in New England are correctly identified. Nevertheless, recent observations (1994 field form of Sperduto) have noted possible confusion between the two taxa, and future surveys should make careful identification notes.

### **SPECIES BIOLOGY**

Other than field forms or accounts of its habitat and its taxonomy, there is little published on the biology of *Carex garberi*. The plants can form small colonies, appearing either as slender clumps or small tufts along rhizomes (personal observation). It is an herbaceous, monoecious perennial whose major pollination agent is wind (Illinois Plant Information Network 2001). The flowering period is listed as early June (New York Natural Heritage Program 1998) to August (Fernald 1950). Plants from seed from New England occurrences of *Carex garberi*, grown at the New England Wild Flower Society's (NEWFS) botanic garden, the Garden in the Woods (Framingham, Massachusetts), have flowered in cultivation as early as the beginning of May and have finished flowering as early as the beginning of June (unpublished data). In addition to variation in flowering/fruitlet times from plants in the wild, these plants also show a different growth habit in cultivation from plants in the wild: becoming taller, more robust, and stiffer than the same plants found in the wild in New England (personal observation). This stiffer, more upright habit is more typical of the appearance of the species in the Midwest (Tony Reznicek, personal communication).

Seed ripening dates can vary considerably. Seymour (1969), citing herbarium material, records mature perigynia from 12 June to 10 July. It is probable that these dates reflect the period when the perigynia are ripe enough to allow for a positive identification of the taxon, not necessarily when the achenes are mature. In New York, fruiting dates are given as 15 June to 1 September (New York Natural Heritage Program 1998). Seed collections deposited at the New England Wild Flower Society were collected on 15 June, 29 June, 30 June, and 6 July of various years (unpublished data). It is likely that flowering occurs at least several weeks before the fruit matures.

As for seed dispersal, a note at NEWFS on a 6 July seed collection indicates that the perigynia would be ready to drop off the plant in one week. The dates of seed ripening and dispersal are important if *Carex garberi* is to be positively identified. *Carex*



*garberi* begins fruiting and dispersal relatively early, and the best time to locate and identify the plant in New England is late June to mid July. Sperduto (1994) noted at a visit to one site on August 30, that the plants were "...past prime, makes accurate count impossible. A few fruiting plants observed and numerous gray-green vegetative leaves. Early season count needed."

Seed collected at Barnet (Vermont) and Claremont and Plainfield (New Hampshire) all germinated after being given a period of moist cold stratification either in a refrigerator (12 weeks) or after being sown outside in a cold frame over winter to germinate the following spring (New England Wild Flower Society, unpublished data). These findings agree in part with Schutz and Rave (1999) who tested the germination responses of 32 temperate *Carex* species and found that the probability of germination was significantly higher after stratification, in light, and at fluctuating temperatures. In addition at NEWFS, seed that was dried at 15-20% relative humidity for one month after collection successfully germinated after being subjected to a moist cold treatment. Because the seed remained viable after drying, it seems likely that seed can be successfully stored in a seed bank for an indefinite period, although this has not been tested.

The major dispersal agents for this taxon are wind and water (Illinois Plant Information Network 2001). Given that the plant is usually found on river ledges and shores in New England, and that populations are usually inundated for a period during the year (see below) dispersal by water is most likely. At least one site is inundated on a daily basis.

Because ice scour and flooding are major annual events for *Carex garberi* (see Habitat and Ecology section), it is possible that some occurrences, particularly those on seepy gravel or cobble, follow a population pattern similar to the Furbish lousewort, *Pedicularis furbishiae*. In the case of *Pedicularis furbishiae*, ice scour along the St. John River can both create open habitat for colonization by seed, and destroy existing occurrences. These stochastic events result in a dynamic mosaic of changing populations (Gawler et al. 1987) and a metapopulation structure (Menges 1990). There is no report of *C. garberi* having a metapopulation structure, but as with *P. furbishiae*, the large annual disturbance events on the river could disrupt occurrences that are found on sandy or gravelly shores, while creating habitat for new occurrences. *Carex garberi* has been found at sites containing *Pedicularis furbishiae*, but where present, *C. garberi* is usually found lower on the shore (Susan Gawler, Maine Natural Areas Program, personal communication). In this regard, it seems likely that other populations of *C. garberi* exist on the St John River (Gawler, personal communication, Josh Royte, Maine TNC, personal communication).

In other locations, however, occurrences of *C. garberi* continue to exist for long periods of time at the same site. At some locations, where herbarium specimens were first collected over 100 years ago, plants still persist (see Status section, below). Many of these long-lived occurrences are on ledges that are scraped clean of woody vegetation by

flooding and ice scour, apparently provide safe harbor for *C. garberi* and other rare species.

## **HABITAT/ECOLOGY**

*Carex garberi* is found in a variety of habitats across its range. Among its habitats are: seepage areas along bogs (USGS 2001); wet, sandy, gravelly, or marly shores; limestone pavements; interdunal flats; edges of cedar thickets (Voss 1972); moist or wet sandy, gravelly or rocky beach flats (Wisconsin DNR 1999); calcareous sands, marly, gravelly shores (Crow and Hellquist 2000); or simply “wet places” in Alaska (Hulten 1968). It is considered a Facultative Wetland plant under the National Wetland Plant Classification System (U.S. Fish and Wildlife Service 2000).

In New England, *Carex garberi* is restricted to calcareous ledges and sandy or gravelly river shores in Maine (Haines and Vining 1998) and seepy ledges and river shores that are flood or ice scoured for a period during the year along rivers in New Hampshire and Vermont. Along the Connecticut River, it is usually found in turf pockets between rocks or in ledges (Sperduto and Gilman 1995).

The plant communities where *Carex garberi* is found are influenced by cyclical ice scour during spring flood events. It is likely that this type of river shore disturbance is very important in maintaining open river habitats for this species, as in the case for Furbish lousewort (*Pedicularis furbishiae*) in Maine (Gawler et al. 1987). In most cases, *C. garberi* is also found in association with seeps, and the flood scouring also maintains these seeps as open ground water discharge sites.

Calcareous riverside seeps occur at river narrows of major rivers and below dams (usually at river narrows where riverside seeps were likely natural) on outcrops and occasionally on sediments of steep terraces or cobble bars where there is year-round influence of groundwater seepage. Daily dam releases may influence, if not create, some artificial seep situations below dams, but most dam sites have natural seep banks as well. Annual flood and ice scour is violent in this area and removes competing woody vegetation (Sperduto and Gilman 1995).

There are a total of twelve dams on the Connecticut River mainstem above sites containing *Carex garberi*. The dams exerting the most influence on *Carex garberi* sites on the Connecticut are: Bellows Falls, Wilder, Ryegate, McIndoes Station, Comferford Station, and Moore Reservoir (U.S. Fish and Wildlife Service 1995). There are no dams on the St. John River in Maine, but dams exist on the Kennebec, Penobscot, and Aroostook Rivers.

Calcareous riverside seeps appear to be restricted to areas with considerable calcareous bedrock influence or at least mineral enriched groundwater. In New Hampshire, the pH of seepage water ranged from 6.8 to 8.2 while the pH of the river water was usually close to 7.0 (Sperduto and Gilman 1995). The soils tends to be turf

sands (i.e., sands impregnated with a tightly woven fine root mass), wedges in the cracks of outcrop, boulders, cobble, and bare outcrops. Less often, seep vegetation can be found in unconsolidated sediments of steep river terraces or silty banks. Partial shading from trees and shrubs is typical (Sperduto and Gilman 1995, and Natural Heritage Program field forms), but some sites are also completely open. Sites in New England have been described as occurring on both east- and west-facing slopes as well as north and south shores of rivers. Aspect seems to make little difference to this plant, but moist conditions though seepage appears to be a common denominator, according to Natural Heritage Program Field Forms. Plants can be located on dry ledges, but they are almost always in moist pockets or seeps within the dry ledge.

Associated native species of *Carex garberi* have included: *Allium schoenoprasum* var. *sibericum* (wild chives); *Alnus rugosa* (Speckled alder); *Andropogon gerardii* (big blue-stem); *Antennaria howellii* ssp. *canadensis* (pussy toes); *Aster novi-belgii* (New York aster); *Aster umbellatus* (flat-topped white aster); *Campanula aparinoides* (marsh bellflower); *Carex aurea* (golden-fruited sedge); *Carex buxbaumii*; *Carex cryptolepis*; *Carex echinata* (prickly sedge); *Carex flava* (Yellow Sedge); *Carex granularis* var. *haleana* (granular sedge); *Carex leptalea* (bristle-stalked sedge); *Cystopteris bulbifera* (bulblet bladder fern); *Deschampsia caespitosa* (tufted hairgrass); *Deschampsia flexuosa* (common hairgrass); *Drosera rotundifolia* (round-leaved sundew); *Eleocharis tenuis*; *Eupatorium* sp.; *Euthamia graminifolia* (slender-leaved goldenrod); *Fragaria virginiana* (wild strawberry); *Hieracium lachenallii*; *Juncus articulatus* (jointed sedge); *Lobelia kalmii* (Kalm's lobelia); *Mimulus moschatus* (musky monkey flower); *Parnassia glauca* (grass-of-Parnassus); *Pentaphylloides floribunda* (shrubby cinquefoil); *Physostegia virginiana* (lion's head); *Poa compressa*; *Primula mistassinica* (bird's-eye primrose); *Rhynchospora capillacea* (few-flowered beak rush); *Rhynchospora capitellata* (beak-rush); *Rubus pubescens* (dwarf raspberry); *Salix* sp. (Willows); *Senecio pauperculis* (northern meadow groundsel); *Solidago hispida* (hairy goldenrod); *Spiranthes lucida* (shining lady's tresses); *Triantha glutinosa* (false asphodel); and *Tricophorum (Scirpus) clintonii* (Clinton's bulrush).

Exotic species found at or nearby *Carex garberi* sites include: *Alnus glutinosa* (black alder); *Coronilla varia* (crownvetch); *Vincetoxicum (Cynanchum) nigrum* (black swallow-wort); *Daucus carota* (Queen Anne's lace); *Lonicera* sp (Honeysuckles); *Lythrum salicaria* (purple-loosestrife); *Melilotus alba* (white sweet clover); *Falliopia (Polygonum) japonica* (Japanese knotweed); and *Viccia cracca* (cow vetch) (Sperduto and Gilman 1995, Natural Heritage Program field forms in Maine, New Hampshire, and Vermont; Everett Marshall (personal communication); Anderson 1997).

## **THREATS TO TAXON**

The major threats to *Carex garberi* in New England are:

### ***Disruption of current disturbance regimes***

Since *Carex garberi* is only found in areas of ice scour and flooding in New England, disruption of these disturbance regimes could have a major impact. In this regard, dams can significantly affect habitat for *C. garberi*. A recent study of hydrologic alteration in the Upper Connecticut River Basin, which includes several sites for *Carex garberi*, showed that present-day impounded rivers have less frequent and lower magnitude floods compared to free-flowing rivers (Magilligan and Nislow 2000). This same study also showed that at the elevations along the river where the federally-listed *Astragalus robbinsii* var. *jesupii* is found (elevations comparable to *C. garberi* occurrences, personal observation), there were smaller differences in flood frequency, but major differences in flood duration (fewer number of days per year the surface was flooded) as compared to free flowing rivers.

Dams and their associated hydrologic changes have been linked to the loss of several occurrences of *Carex garberi*, according to several EO records. Although damming of the Connecticut River has had a major impact on river habits, especially floodplain forests, and several sites of *C. garberi* have been destroyed by alteration of river hydrology (see Current Status section), it appears that *C. garberi* can continue to exist under current hydrologic regimes. A number of dams are currently up for re-licensing, however, and rare plant habitat will be considered in this process (Doug Bechtel, The Nature Conservancy, personal communication).

Significant changes in hydrologic regime could negatively impact *C. garberi*. Construction of new dams and stream bank construction activities related to the functioning of the current power plants could also be a threat (according to Natural Heritage Program field forms, especially Rawinski's 1994 field form on the Comerford Dam). The removal of dams could theoretically also negatively impact current localities of *Carex garberi*. If water flows are increased to such a level that existing occurrences are constantly, as opposed to seasonally or sporadically inundated, the plants may not survive. While dam removal could theoretically negatively affect downstream habitat, removal could also result in a gain in habitat upstream of the dam.

### ***Adjacent landowner use***

Some occurrences of *Carex garberi* could be affected by adjacent landowner use. Groundwater discharge through seeps is one of the most important factors for maintaining *C. garberi*, and any activity that affects groundwater discharge (i.e., drilling of wells, etc.) could also affect *C. garberi* populations. Changes to the hydrology and drainage on lands adjacent to the *C. garberi* sites are difficult to assess and regulate, however, and in at least one instance, lands adjacent to a *Carex garberi* site have been completely developed for some years.

There is also concern about the effects of timber harvest, both on the shorelines and to river quality. The U. S. Fish and Wildlife Service (1983) notes that upland

clearing for agriculture and camps can adversely impact *Pedicularis furbishiae*, a rare species that occurs with *Carex garberi* at certain sites. At other sites along the St. John River, there is concern over dumping of cut vegetation down the bank that could affect *C. garberi* (Susan Gawler, personal communication). At one Vermont site, bridge replacement may have an impact (Everett Marshall, personal communication).

### ***Recreation***

Use of habitat containing *C. garberi* for recreation -- canoeing, kayaking, camping, or fishing -- is of concern. Since numbers of plants are low at some sites, the plants could be threatened if enough individuals make recreational use of the shoreline habitat. Recreation is considered a threat to some ecologically important habitats in the Connecticut River including at least one site for *Carex garberi* (Anderson 1997). Trampling is of concern at a popular swimming site in Vermont (Everett Marshall, personal communication).

### ***Invasive non-native species***

Invasive exotic species pose a possible threat to *C. garberi*. In Maine along the St. John River, *Lythrum salicaria* is starting to appear. Efforts should be made to educate local landowners not to plant this species in their home gardens because of its potential to invade wetland habitats (Josh Royte, personal communication). Because of the severe disturbance regime associated with high-energy river sites, invasive exotic species may not be able to gain a hold directly in the habitat of *C. garberi*. Yet the continual deposition of silt provides open soil, often the perfect breeding ground for exotic species invasions. Recent studies of the Connecticut River have inventoried and mapped invasive non-native plants that threaten rare plant populations and natural communities near *Carex garberi* sites (Anderson 1997). Several sites of *C. garberi* on the Connecticut River are near populations of *Fallopia japonica* (*Polygonum cuspidatum*), an invasive species that poses a particular threat to the shores along the river.

### ***Increased atmospheric temperatures***

*Carex garberi* is primarily a northern species reaching the southern limits of its range in the east in New England. Although it occurs as far south as Pennsylvania and Ohio along the shores of Lake Erie (Rhodes and Klein 1993), increased temperatures caused by global warming could negatively affect this species in New England.

## **DISTRIBUTION AND STATUS**

### *General status*

At the northern edge of its range, *Carex garberi* is found from Alaska, Saskatchewan, and Manitoba to Quebec and New Brunswick (Figure 1). Its range does extend southward into California and Oregon on the west coast, but the southern edge of its range is located primarily from North Dakota to Illinois and Indiana, east to the shores of Lake Erie in Ohio and Pennsylvania and northeastward to Maine (NatureServe 2001). *Carex garberi* is ranked as G4 (NatureServe 2001), indicating a taxon that is widespread, but apparently infrequent in portions of its range. Within the Connecticut River watershed, the plant (as *Carex garberi* var. *bifaria*) is ranked W1 (a rare species with 20 or fewer occurrences within the watershed states) by the Silvio O. Conte National Fish and Wildlife Refuge (U. S. Fish and Wildlife Service 1995). In New England, *C. garberi* is limited to the states of Maine, New Hampshire, and Vermont (Figures 2 and 3).

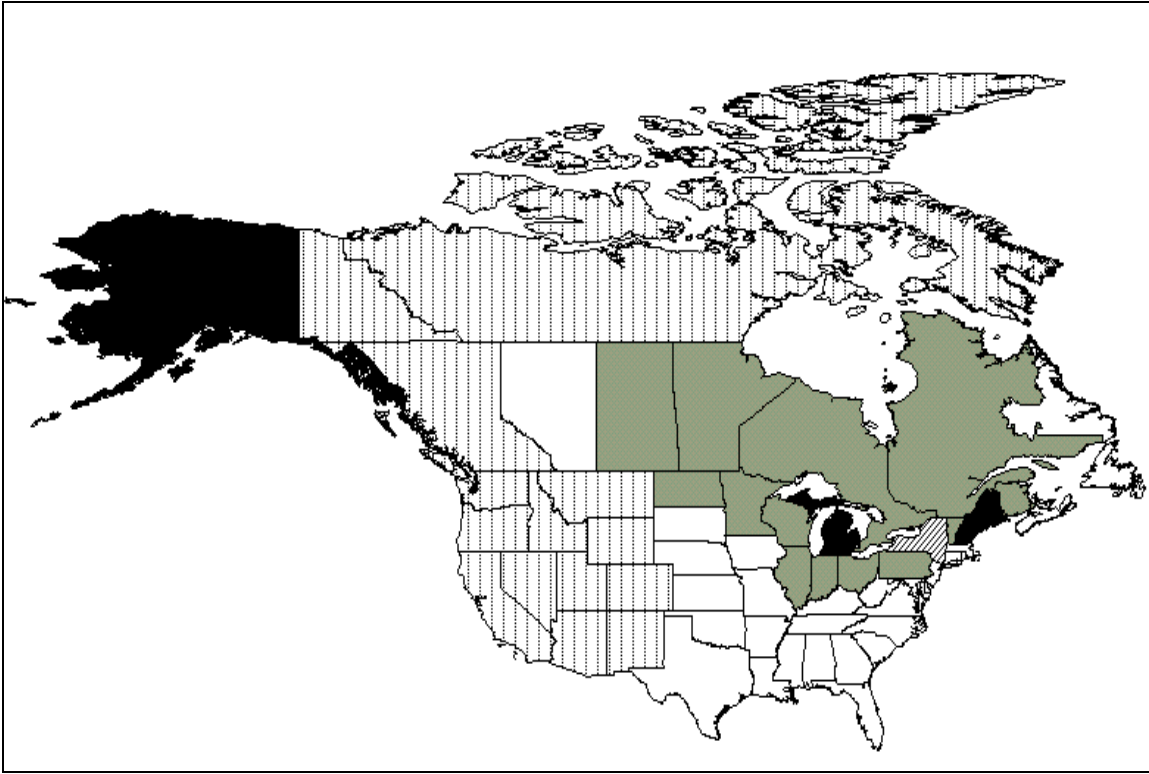
Based on a global rank at the time of publication (G4T3Q as *Carex garberi* var. *bifaria*) in *Flora Conservanda*: New England (Brumback and Mehrhoff et al. 1996), the taxon was considered Division 1 (Globally Rare) in New England. Given the current number of occurrences, the taxon might now be considered Regionally Rare or, even more probably, Division 3 (Locally Rare).

The status of *Carex garberi* in each state and province within its range is given in Table 1. The taxon is considered S1 (Critically Imperiled) or S2 (Imperiled) in 13 states or provinces. In the states or provinces directly contiguous to New England, *C. garberi* is considered historic (SH) in New York, vulnerable (S3?) in Quebec and critically imperiled (S1) in New Brunswick.

Although not listed in the first edition of the *Flora of New Brunswick* (Hinds 1985), *Carex garberi* is shown in the latest edition (Hinds 2000) as occurring on the St. John River on the New Brunswick side between Fort Kent and St. Francis. According to Sean Blaney (Atlantic Canada Conservation Data Center, personal communication), it is known from 10 locations in New Brunswick (with two locations on the St. John River).

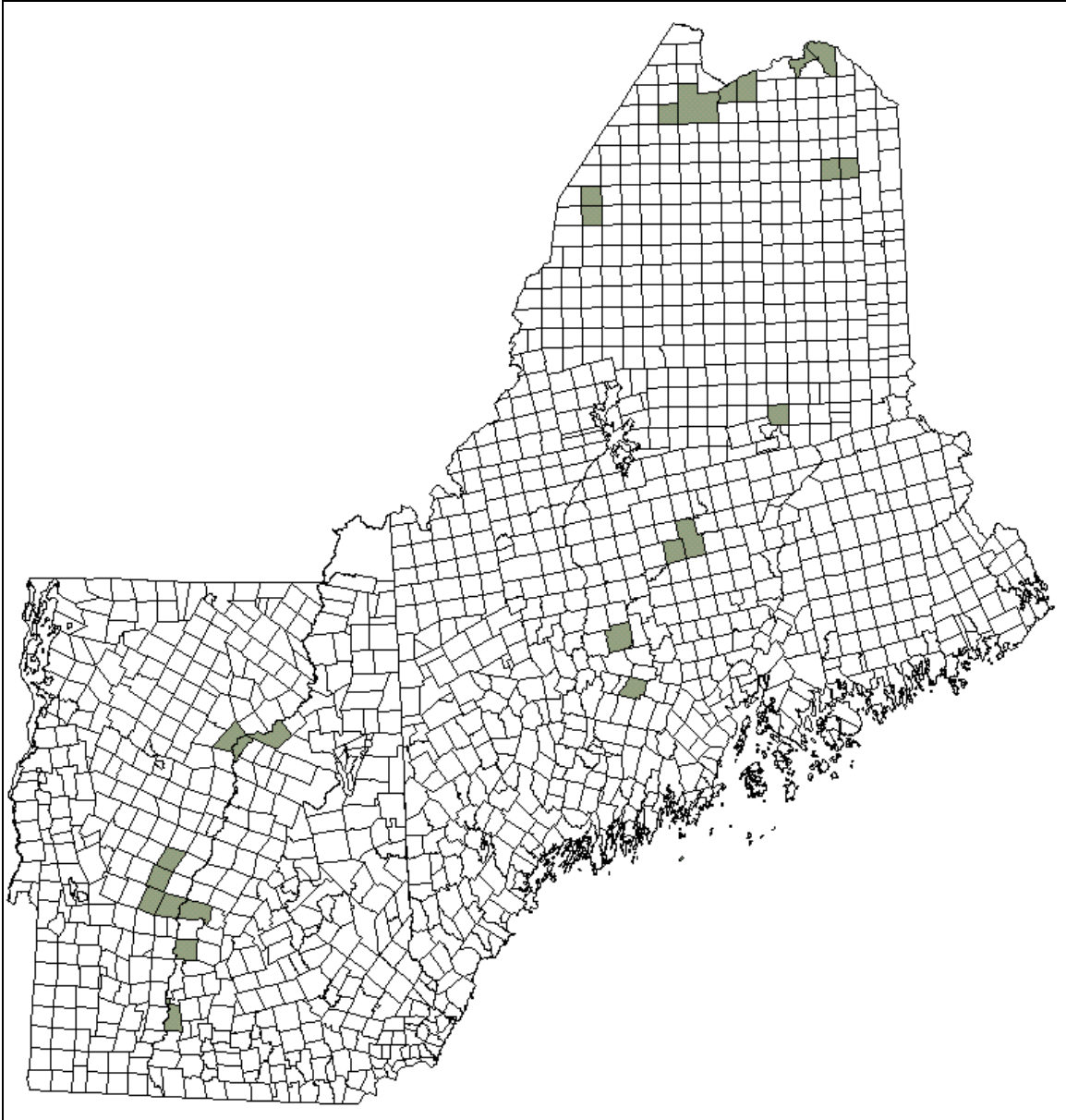
In Quebec, the nearest occurrences to New England are located near Quebec City and on the Gaspé Peninsula. There are no occurrences within 50 miles of the border with the United States, and *Carex garberi* is not considered a rare species in the province of Quebec (Stuart Hay, Herbar Marie-Victorin, University of Montreal, personal communication).

<b>Table 1. Occurrence and status of <i>Carex garberi</i> in the United States and Canada based on information from Natural Heritage Programs</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED (SR) OR FALSE (SRF)</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Illinois (S1)	Alaska (S3S4)	Arizona (SR)	New York (SH)
Indiana (S2)	Michigan (S4)	California (SR)	
Maine (S2, SC) - 17 extant and 6 historic occurrences.	Ontario (S3?)	Colorado (SR)	
Minnesota (S2)	Quebec (S3?)	Idaho (SR)	
New Hampshire (S1, E) 5 extant occurrences.		Montana (SR)	
North Dakota (S1S2)		Nevada (SR)	
Ohio (S1S2)		New Mexico (SR)	
Pennsylvania (S1)		Oregon (SR)	
Vermont (S1, T) - 4 extant and 2 historic occurrences.		Utah (SR)	
Wisconsin (S1)		Washington (SR)	
Manitoba (S1?)		Wyoming (SR)	
New Brunswick (S1)		Alberta (SRF)	
Saskatchewan (S2)		British Columbia (SR)	
		Northwest Territories (SR)	
		Newfoundland (SRF)	
		Yukon Territory (SR)	

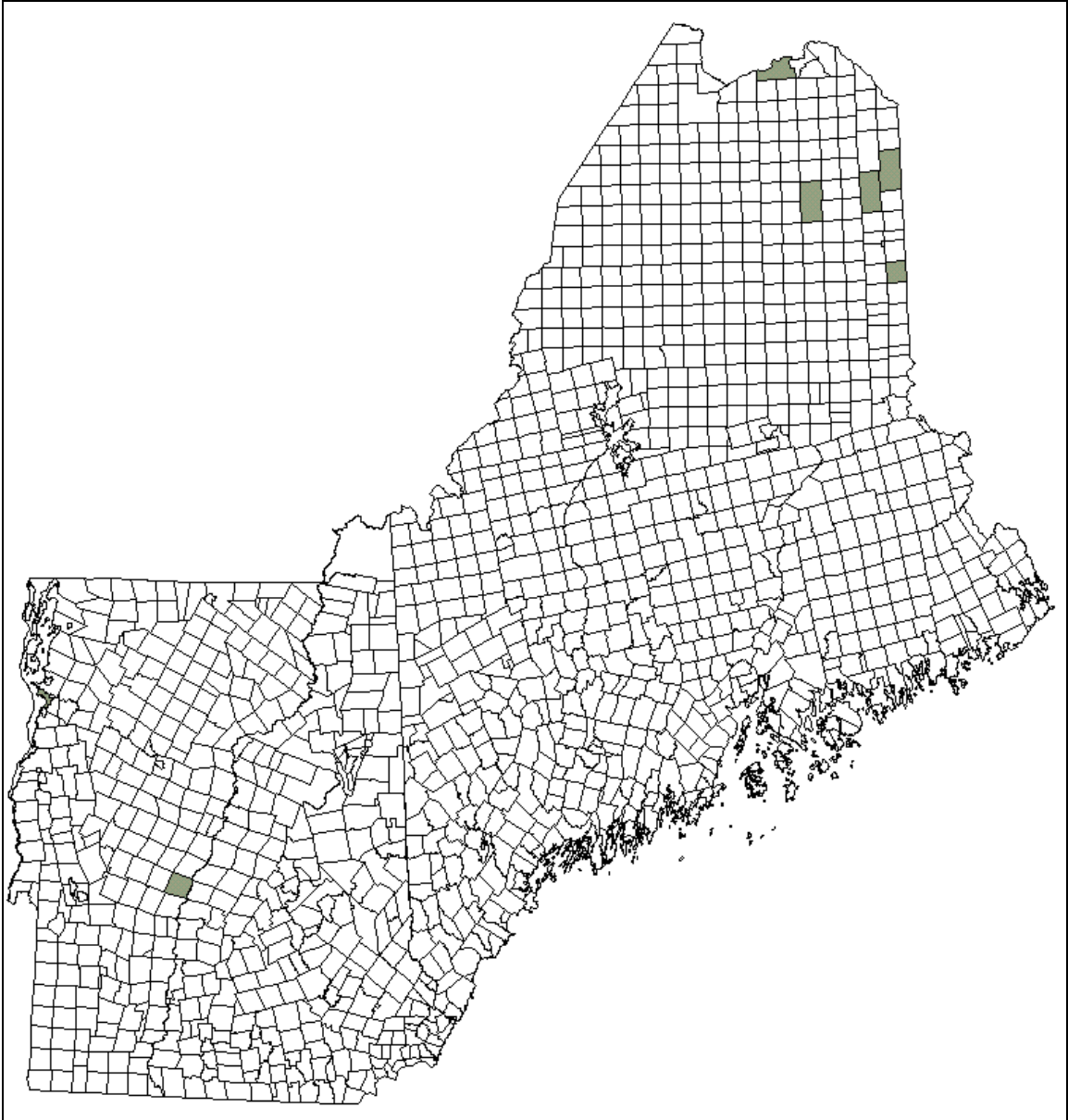


**Figure 1. Occurrences of *Carex garberi* in North America.** States and provinces shaded in gray have one to five (or an unspecified number of) extant occurrences of the taxon. States shaded in black have more than five occurrences. Stippling indicates areas where the taxon is ranked "SR" ("reported;" see Appendix for explanation of NatureServe ranks). The state with diagonal hatching (New York) is ranked "SH," where the taxon no longer occurs.





**Figure 2. Extant occurrences of *Carex garberi* in New England.** Towns for Maine, New Hampshire, and Vermont are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.



**Figure 3. Historic occurrences of *Carex garberi* in New England.** Towns shaded in gray have one to five historic records of the taxon.

**Table 2. New England Occurrence Records for *Carex garberi*. Shaded occurrences are considered extant.**

<b>State</b>	<b>EO Number</b>	<b>County</b>	<b>Town</b>
<b>ME</b>	<b>.001</b>	<b>Kennebec</b>	<b>Winslow</b>
<b>ME</b>	<b>.002</b>	<b>Kennebec</b>	<b>Winslow</b>
<b>ME</b>	<b>.003</b>	<b>Piscataquis</b>	<b>Sangerville</b>
<b>ME</b>	<b>.004</b>	<b>Piscataquis</b>	<b>Dover-Foxcroft</b>
<b>ME</b>	<b>.005</b>	<b>Aroostook</b>	<b>T11 R16 WELS</b>
<b>ME</b>	<b>.006</b>	<b>Aroostook</b>	<b>St. Francis</b>
<b>ME</b>	<b>.007</b>	<b>Aroostook</b>	<b>Frenchville/Madawaska</b>
<b>ME</b>	<b>.008</b>	<b>Penobscot</b>	<b>Grindstone TWP</b>
<b>ME</b>	<b>.009</b>	<b>Aroostook</b>	<b>Washburn</b>
<b>ME</b>	.010	Aroostook	Fort Fairfield
<b>ME</b>	.011	Aroostook	Presque Isle
<b>ME</b>	.012	Aroostook	Monticello
<b>ME</b>	.013	Aroostook	Ashland
<b>ME</b>	.014	Aroostook	Ft. Kent
<b>ME</b>	<b>.015</b>	<b>Aroostook</b>	<b>St. John Pt.</b>
<b>ME</b>	.016	Lincoln	Monhegan Pt.
<b>ME</b>	<b>.017</b>	<b>Aroostook</b>	<b>Allagash</b>
<b>ME</b>	<b>.018</b>	<b>Aroostook</b>	<b>T16 R12 WELS</b>
<b>ME</b>	<b>.019</b>	<b>Aroostook</b>	<b>Wade</b>
<b>ME</b>	<b>.020</b>	<b>Somerset</b>	<b>Skowhegan</b>
<b>ME</b>	<b>.021</b>	<b>Aroostook</b>	<b>Allagash</b>
<b>ME</b>	<b>.022</b>	<b>Aroostook</b>	<b>T12 R16 WELS</b>

<b>Table 2. New England Occurrence Records for <i>Carex garberi</i>. Shaded occurrences are considered extant.</b>			
<b>State</b>	<b>EO Number</b>	<b>County</b>	<b>Town</b>
<b>ME</b>	<b>.023</b>	<b>Aroostook</b>	<b>T11 R16 WELS</b>
<b>NH</b>	<b>.001</b>	<b>Sullivan</b>	<b>Plainfield</b>
<b>NH</b>	<b>.002</b>	<b>Grafton</b>	<b>Monroe</b>
<b>NH</b>	<b>.003</b>	<b>Sullivan</b>	<b>Plainfield</b>
<b>NH</b>	<b>.004</b>	<b>Cheshire</b>	<b>Walpole</b>
<b>NH</b>	<b>.005</b>	<b>Grafton</b>	<b>Littleton</b>
<b>NH</b>	<b>No #</b>	<b>Sullivan</b>	<b>Claremont</b>
<b>NH</b>	<b>New</b>	<b>Sullivan</b>	<b>Claremont</b>
<b>VT</b>	<b>.001</b>	<b>Windsor</b>	<b>Sharon/ Pomfret</b>
<b>VT</b>	<b>.002</b>	<b>Windsor</b>	<b>Hartland</b>
<b>VT</b>	<b>.003 now part of .001</b>	<b>Windsor</b>	<b>Sharon</b>
<b>VT</b>	<b>.004</b>	<b>Chittenden</b>	<b>Burlington</b>
<b>VT</b>	<b>.005</b>	<b>Windsor</b>	<b>Hartford</b>
<b>VT</b>	<b>.006</b>	<b>Caledonia</b>	<b>Barnet</b>
<b>VT</b>	<b>New site?</b>	<b>Windsor</b>	<b>Woodstock</b>

### **CURRENT CONSERVATION MEASURES IN NEW ENGLAND**

At the federal level, there are several laws that serve, directly or indirectly, to protect *Carex garberi* on river systems in New England. The U.S. Endangered Species Act (ESA) prohibits federal agencies from providing funding for any project that would harm a federally listed species. Although *Carex garberi* is not listed under this Act, there are at least two federally listed plants located with or near *Carex garberi* occurrences in two major rivers: *Astragalus robbinsii* var. *jesupii* on the Connecticut River and *Pedicularis furbishiae* on the St. John River. Therefore, close scrutiny will theoretically be paid to the effects of any proposed dam construction projects to these river systems. Federal financing for a proposed dam on the St. John River could not be given because

the dam's impoundment would have destroyed a large portion of habitat for *Pedicularis furbishiae*. The ESA does not, however, protect federally listed species on private land.

A number of dams are currently up for re-licensing on the Connecticut River, and rare plant habitat will be considered in this process (Doug Bechtel, personal communication). In other laws, the review processes imposed by The National Environmental Policy Act of 1969 and the Federal Power Act of 1986 may also provide indirect protection for river habitat (U.S. Fish and Wildlife Service 1995).

The Silvio O. Conte National Fish and Wildlife Refuge Act of 1991 authorizes the establishment of a refuge in the Connecticut River watershed of Connecticut, Massachusetts, New Hampshire, and Vermont. Refuge objectives include protecting the river's fish and wildlife resources, with primary emphases on environmental education, and fostering cooperative agreements with state and local governments and private landowners (U.S. Fish and Wildlife Service 1995).

Each of the three states where *Carex garberi* occurs have laws protecting endangered species. *Carex garberi* is officially listed in Vermont (as Threatened), New Hampshire (as Endangered) and Maine (as Special Concern). Vermont law prohibits take, including damage to listed plants, possession, and sale, but also states that rules adopted under the act shall not unduly interfere with agricultural or forestry practices. New Hampshire's law exempts landowners' actions on their own land, but prohibits the taking of listed species from someone else's private property without written permission (U.S. Fish and Wildlife Service 1995). Maine law provides no rare plant protection other than listing (Don Cameron, Maine Natural Areas Program, personal communication).

In Maine, The Nature Conservancy has purchased a large amount of land in the upper St. John River watershed (including whole townships in some instances). For the remaining sections of the river, they are looking to obtain easements, establish riparian buffers, or enable Green Certification under the Forest Stewardship Council program of land adjacent to the river up to Allagash -- a full 130 miles (Josh Royte, personal communication). In an extraordinary protection program, TNC, in combination with other groups, state, and provincial organizations has placed some type of protection over two thirds of the Upper St. John River watershed (The Nature Conservancy 2001).

A number of occurrences of *Carex garberi* including ME .005 (T11 R16 WELS), ME .018 (T16 R12 WELS), .022 (T12 R16 WELS), .023 (T11 R16 WELS) are thus receiving some form of protection. In addition, the Maine Natural Areas Program is working to contact landowners adjacent to the river in the section below Big Rapids about the importance of maintaining the sensitive habitat (Susan Gawler, personal communication). Maine has several laws which protect riverbank habitat to some degree. These laws include the Shoreline Zoning Act as well as a series of articles within the Forest Laws of Maine (Don Cameron, personal communication).

In New Hampshire, one population of *Carex garberi* is owned by New Hampshire TNC (NH .003 [Plainfield]). TNC also has a Cooperative Agreement with US GEN, the utility company owning land at *C. garberi* sites along the Connecticut River. US GEN

has designated certain areas (including NH .002 [Monroe] and .004 [Walpole]) as “Special Habitats,” in which New Hampshire TNC is allowed to monitor these areas and provide management advice. Furthermore, in the future, US GEN intends to donate land it owns on both the New Hampshire and Vermont sides of the river where *Carex garberi* is found (NH .001 [Plainfield] and VT .002 [Hartland]) to a conservation group or public agency such as the Silvio O. Conte National Fish and Wildlife.

In Vermont, no law specifically providing buffers along rivers exists, but individual towns often have zoning regulations regarding setbacks from rivers. Unfortunately, a huge variation exists in zoning regulations between towns (Everett Marshall, Vermont Nongame and Natural Heritage Program, personal communication). Also in Vermont, protection under Act 250, a regulatory process triggered by developments of large size (greater than 10 acres or 9 units or more), can provide buffer zones to streams and rivers. Typical buffers might be designated as 50 ft. or 100 ft. stream or river edge for projects of great enough size to trigger the Act. (Typically, a single-family home is not large enough to trigger Act 250 regulations). Several sites for *Carex garberi* in Vermont are on protected land (state land or private conservation land) including VT.001 (Sharon/Pomfret), and .003 (Sharon).

Recreation is considered a threat to some ecologically important habitats in the Connecticut River including at least one site for *Carex garberi* (Anderson 1997). An outreach brochure for recreational users of the Connecticut River has been developed by TNC to inform users of the location and importance of the vulnerable species and habitats on the islands and other sites (Anderson 1997).

Seed has been collected for seed banking as part of the seedbanking program of NEPCoP. Seed from four sites, (NH .001 [Plainfield], NH .002 [Monroe], a new site in New Hampshire [Claremont], and VT.006 [Barnet] has been collected, cleaned, dried, and placed in a seed bank at approximately -20° C. Normally, seed that can survive being dried to 15-20% relative humidity will also survive storage at the freezing temperatures of the seed bank. In several of the seed tests performed to assess viability of seed before banking, germination of *Carex garberi* seed actually improved after drying (unpublished germination records, NEWFS). While no seed tests have been performed on seed held in storage for more than six years, it seems likely that *Carex garberi* can be successfully stored in a seedbank, at least in the short term.

## II. CONSERVATION OF *CAREX GARBERI*

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### CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

The general conservation objective for this taxon is to maintain the current number of extant occurrences in New England. Past surveys have shown that numbers of plants at an occurrence can fluctuate greatly. (This may partly be due to the difficulty of identifying *Carex garberi* in its vegetative state.) For this reason, setting goals for numbers of plants at each site is difficult. A number of sites have existed for many years with relatively small numbers of plants. Since the increasing numbers of plants at high-energy riverside sites is likely to prove difficult, the general objectives for number of plants at a site may need to be revised downward for sites with historically smaller numbers. It should be noted that conservation actions at a particular site should be coordinated with conservation planning for other rare plants (i.e., *Triantha glutinosa*, *Rhynchospora capillacea*, etc.) at the site.

Because *Carex garberi* is no longer considered globally rare, it will likely not be considered a Division 1 taxon in future editions of *Flora Conservanda: New England* (see page 242 for definitions, Brumback and Mehrhoff et al. 1996). Similarly, with 27 current occurrences throughout New England, it would also not meet the criteria for Regionally Endangered (Division 2). The ten current occurrences in the Connecticut River watershed in New Hampshire and Vermont, however, would be probably be listed as Division 3 (locally rare) because they are disjunct to such a degree that genetic isolation is likely (because they are separated from the other New England occurrences, all of which are in Maine, more than 50 miles away). Furthermore, these Connecticut River watershed occurrences are also disjunct from any occurrences in Quebec. Because of this disjunction, and because large areas of undiscovered suitable habitat (i.e., calcareous riverside seeps) is not likely to be discovered on the Connecticut River itself, the conservation of these Connecticut River occurrences is the most important objective for the species in New England.

Within Maine itself, the plant is currently extant along the shores of five of Maine's major rivers: the Kennebec, the Piscataquis, the Penobscot, the Aroostook, and the St. John. The species was formerly found along the Meduxnekeag River, but is presumed extirpated there. Nine of the 17 current occurrences in Maine are found on the St. John River, and thus conservation of the taxon within this river system will preserve the majority of occurrences in the state. Furthermore, given that suitable habitat for *Carex garberi* is relatively abundant along this river, it seems likely that other yet undiscovered occurrences also exist on the St. John.

Of the remaining current occurrences, three are on the Kennebec, one is on the Penobscot, and two are on the Aroostook Rivers. These occurrences, located on separate major river systems, are also separated by almost 50 miles or more from each other. It is therefore recommended that these current occurrences also be preserved. There is one

current occurrence, ranked “D” on the Piscataquis River (ME .004), but no plants could be located in 1990 and the site is likely overgrown. Conservation of occurrences along this river system is not recommended at this time unless additional surveys show that viable occurrences exist.

In summary, prioritized conservation actions for *Carex garberi* in New England are to maintain:

- eleven occurrences in the Connecticut River watershed
- nine occurrences along the St. John River in Maine
- the six current number of occurrences along each of the Kennebec (3), the Penobscot (1), the Aroostook Rivers (2) in Maine
- an average of 50-100 plants for each occurrence, with at least 50-75% of the plants fruiting, is a reasonable objective for most sites.



### III. BACKGROUND FOR *TRIANTHA GLUTINOSA*

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#### DESCRIPTION

*Triantha (Tofieldia) glutinosa* (Michx.) Baker (Liliaceae) is a short, rhizomatous, herbaceous perennial that grows to 2-5 dm in height. The leaves are usually several (but also may be singular or absent) and basal, being 2-ranked, broadly linear, 8-20 cm long to 8 mm broad, and reaching one-half to two-thirds the length of the scape. A single, bract-like cauline leaf near the middle of the stem may be present. The flowering scapes are stiff and sticky-hairy near the inflorescence, which is a terminal, 1-8 cm long x 1-2 cm-wide raceme. The white flowers are fascicled, two or three together at each node on sticky-hairy 3-6 mm long pedicels. The oblanceolate tepals are 4 mm long and each is subtended just below the perianth by small ovate bractlets. The fruit is ovoid, thin-walled capsule 5-6 mm long. The seeds are fusiform, thin-walled, about 1-1.3 mm long with a filiform contorted appendage at each end (Fernald 1950, Gleason and Cronquist 1991, Crow and Hellquist 2000).

#### TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

*Triantha glutinosa* (Michx.) Baker was first described by Michaux as *Nartheccium glutinosum* in 1803. In 1805, Persoon changed the name to *Tofieldia glutinosa* (Michaux) Persoon. Later, Baker (1879) placed the taxon in another genus as *Triantha glutinosa* (Michx.) Baker. Some authors, notably Small (1903), followed Baker's treatment, but many others, including Fernald (1950), maintained the taxon under *Tofieldia*. Gates (1918) also maintained the plant as *Tofieldia glutinosa*, but separated it partly into another western species *Tofieldia occidentalis* (S. Watson) Gates.

Hitchcock (1944), in his study of the western complex of *Tofieldia glutinosa*, identified five closely related entities and treated them all as varieties of the *Tofieldia glutinosa* complex in the Western United States including (var. *absona*, var. *brevistyla*, var. *glutinosa* (typical), var. *montana*, and var. *occidentalis*). With the exception of var. *glutinosa*, these varieties have been transferred to *Tofieldia occidentalis* (Packer 1993). In the eastern U.S., Ahles (Radford et al. 1964) placed *T. glutinosa* under *Tofieldia racemosa* (Walt.) B.S.P. var. *glutinosa* (Michx.) Ahles. Most authors in the east, including Gleason and Cronquist (1991), however, continued to recognize the taxon as *Tofieldia glutinosa*.

In 1993, following the example of Baker (1879) and Gates (1918), Packer recognized the genus *Triantha* and transferred *Tofieldia glutinosa* to *Triantha glutinosa* (Michaux) Baker. In making the transfer, Packer noted that there is a homogeneous group of three species that includes *Tofieldia glutinosa*, *T. occidentalis* and its various varieties, and *T. racemosa* (Walter) Britton. These three taxa are separated from the genus *Tofieldia* in having glandular, pubescent stems (rather than glabrous stems) and

racemes with multiple flowers per node (instead of always one per node). These features, together microscopic differences in leaf epidermis, led him to place these three taxa including *T. glutinosa* in the genus *Triantha* (Packer 1993). No varieties are listed under *Triantha glutinosa*.

All New England states where this taxon occurs currently maintain the taxon as *Tofieldia glutinosa*. However, NEPCoP nomenclature conventions in “*Flora Conservanda: New England*” (Brumback and Mehrhoff et al. 1996) adopt current and future editions of *Flora of North America* as the primary sources for nomenclature. John G. Packer, Department of Botany, University of Alberta, the author for this taxon in a future volume of *Flora of North America* (Packer 1993), will cite this taxon in *Flora of North America* as *Triantha glutinosa*. Therefore, the name used in this Conservation and Research Plan for the taxon is *Triantha glutinosa* (Michaux) Baker. Please note that in this Plan, the name *Triantha* will be used, but the taxon may be cited under *Tofieldia* in the references given.

*Triantha glutinosa* is widespread in the United States, occurring from Newfoundland to Alaska south to New York, Indiana, and California and also in the mountains to West Virginia and North Carolina (Gleason and Cronquist 1991). In the west, *T. glutinosa* overlaps in part with *Triantha occidentalis* and its varieties, which are found from California to Alaska inland to Alberta, British Columbia, and Idaho. *Triantha glutinosa* is readily separated from *T. occidentalis* by differences in seed cover, shape of inflorescences, and shape of glandular hairs below the inflorescence (Packer 1993).

Only one other member of the genus *Triantha* occurs in the eastern United States: *Triantha racemosa* (Walter) Small. *Triantha racemosa* is found chiefly in wet pinelands and bogs (Gleason and Cronquist 1991) on the coastal plain from Florida to Texas north to New Jersey (Fernald 1950). Its range has never been known to extend into New England. Hybrids between *T. glutinosa* and *T. racemosa* have been found in Burlington County, New Jersey. Packer (unpublished draft treatment of *Triantha* for *Flora of North America*, 1999) suggests that the two species may have had overlapping ranges in the northeast at one time.

*Tofieldia pusilla* (Michx.) Persoon, with pedicels that are solitary and bractless at the top along with glabrous scapes, is circumboreal on wet rocks and alpine or arctic meadows in North America south to Quebec, Isle Royale, northern Minnesota, and Montana. It is not known to occur in New England, and is distinguished from *Triantha glutinosa* by its solitary pedicels without bractlets at the top and its glabrous scape (Gleason and Cronquist 1991). Thus, *Triantha glutinosa* is the only species in the genus that occurs in New England.

## **SPECIES BIOLOGY**

There is little published on the biology of *Triantha glutinosa*. It is an herbaceous, unisexual (monoecious) perennial (Gleason and Cronquist 1991, Ohio DNR 2001). Although said to be rhizomatous (Crow and Hellquist 2000), New England plants do not appear to form significantly connected colonies. Instead, they appear usually as single plants with small tufts or only a pair of basal leaves (personal observation).

The flowering period is listed as June-August, and fruit is produced in September to mid- October (New York Natural Heritage Program 1998). At least one New England EO record cites that plants were past fruiting by 26 August 1990 (according to an unpublished VT Nongame and Natural Heritage Program field form). Probably the best time to observe flowering plants is mid to late June into early July. Although seed is listed as being ripe from September to mid-October (New York Natural Heritage Program 1998), seed ripening dates may vary considerably based on latitude, amount of spring flooding, etc.

According to one source (Clothier's Garden Walk and Talk 2001), seed germinates without pretreatment at 20°C (68°F). If no germination occurs in 304 weeks, move seeds to a treatment of -4°C to + 4°C (24-39°F) for 2-4 weeks. Although there are no reports of seed storage in seed banks, it seems likely that storage will be successful.

Given that the plant is usually found on river ledges and shores in New England, and that populations are usually inundated for a period during the year (see below), seed dispersal by water seems most likely.

Because ice scour and flooding are major annual events for *Triantha glutinosa* in New England (*see* Habitat and Ecology section), it is possible that some occurrences, particularly those on seepy gravel or cobble, follow a population pattern similar to the Furbish Lousewort, *Pedicularis furbishiae* (and potentially *Carex garberi* –see species biology section of *Carex garberi*). There is no report of *T. glutinosa* having a metapopulation structure, but as with *P. furbishiae*, the large annual disturbance events on the river could disrupt occurrences that are found on sandy or gravelly shores, while creating habitat for new occurrences. *Triantha glutinosa* has been found at sites containing *Pedicularis furbishiae* (Don Cameron, personal communication), but it is also present in many other river shores in Maine where *Pedicularis furbishiae* is not known to exist. In this regard, for this type of habitat, it seems likely that many undocumented populations of *Triantha glutinosa* exist on the St. John River, Allagash, and Aroostook Rivers in Maine (Don Cameron, personal communication).

In some locations, occurrences of *Triantha glutinosa* continue to exist for long periods of time at the same site. Plants still persist at some locations where herbarium specimens were first collected over 100 years ago (see Status section, below). Many of these long-lived occurrences are on ledges that are scraped clean of woody vegetation by flooding and ice scour and apparently provide safe harbor for *Triantha glutinosa* and other rare species.

## **HABITAT/ECOLOGY**

Crow and Hellquist (2000) list *Triantha glutinosa* habitat as calcareous shores, gravels, marshes, and damp ledges. Similar to many other species, it apparently inhabits different habitats in different parts of its range. It is found in calcareous fens in Wisconsin (Wisconsin 2001) and wet, open marly soil, fens, calcareous ledges and shores in Ohio (Ohio DNR 2001). It is considered a Facultative Wetland plant under the National Wetland Plant Classification System (U.S. Fish and Wildlife Service 2000).

In New England, the species is restricted to: (a few) fens; circumneutral ledges and shores in Maine (Haines and Vining 1998); and seepy ledges and river shores that are flooded or ice-scoured for a period during the year along rivers in New Hampshire and Vermont. Along the Connecticut River, it is usually found in turfy pockets between rocks or in ledges (Sperduto and Gilman 1995). In general, the plant appears in many of the same habitats as *Carex garberi*, but does not appear to be as restricted in its habitat preferences or numbers as *C. garberi* (Arthur Haines, personal communication).

Like *C. garberi*, the plant communities where *T. glutinosa* is found are the result of cyclical ice scour during spring flood events. It is likely that this type of river shore disturbance is very important in maintaining open river habitats for this species, as is the case for Furbish Lousewort (*Pedicularis furbishiae*) in Maine (Gawler et al. 1987). In most cases, *T. glutinosa* is also found in association with seeps, and the flood scouring also maintains these seeps as open ground water discharge sites.

Calcareous riverside seeps occur at river narrows of major rivers and below dams (usually at river narrows where riverside seeps were likely natural) on outcrops and occasionally on sediments of steep terraces or cobble bars where there is year-round influence of groundwater seepage. Daily dam releases below dams may influence if not create some artificial seep situations, but most dam sites have natural seep banks as well. Annual flood and ice scour is violent in these areas and removes competing woody vegetation (Sperduto and Gilman 1995).

As for *Carex garberi*, there are a total of twelve dams on the Connecticut River mainstem above sites containing *T. glutinosa*. The dams exerting the most influence sites on the Connecticut are Bellows Falls, Wilder, Ryegate, McIndoes Station, Comferford Station, and Moore Reservoir (U.S. Fish and Wildlife Service 1995). There are no dams on the St. John River in Maine, but dams exist on the Kennebec, Penobscot, and Aroostook Rivers.

Calcareous riverside seeps appear to be restricted to areas with considerable calcareous bedrock influence or at least mineral enriched groundwater. In New Hampshire, the pH of seepage water ranges from 6.8 to 8.2 while the pH of the river water is usually close to 7.0. The soils tend to be turfy sands (i.e., sands impregnated with a tightly woven fine root mass) wedges in the cracks of bare outcrops, boulders, and cobbles. Less often, seep vegetation can be found in unconsolidated sediments of steep river terraces or silty banks. Partial shading from tree and shrubs is typical (Sperduto and

Gilman 1995, unpublished data from Natural Heritage Program Field Forms), but some sites are also completely open. Sites in New England have been described as occurring on both east- and west-facing slopes as well as north and south shores of rivers. Aspect seems to make little difference to this plant, but moist conditions though seepage appears to be a common denominator. Plants can be located on dry ledges, but they are almost always in moist pockets or seeps within the dry ledge.

Associated native species of *Triantha glutinosa* are similar to those of *Carex garberi* and include: *Andropogon gerardii*, *Aster novi-belgii*; *Aster umbellatus*; *Carex aurea*, *Carex buxbaumii*, *Carex cryptolepis*; *Carex echinata*, *Carex flava*, *Carex garberi*; *Carex leptalea*, *Cystopteris bulbifera* (bulblet bladder fern), *Deschampsia caespitosa*, *Deschampsia flexuosa*, *Drosera rotundifolia*, *Eleocharis tenuis*; *Eupatorium* sp.; *Fragaria virginiana*, *Juncus articulatus*, *Lobelia kalmii*, *Mimulus moschatus*, *Parnassia glauca*, *Pentaphylloides floribunda*, *Physostegia virginiana*, *Poa compressa*, *Primula mistassinica*, *Rhynchospora capillacea*, *Rhynchospora capitellata*, *Rubus pubescens*, *Senecio pauperculus*, *Spiranthes lucida*, and *Tricophorum (Scirpus) clintonii*.

Exotic species found at or nearby *T. glutinosa* sites include *Alnus glutinosa*, *Coronilla varia* (crownvetch), *Vincetoxicum (Cynanchum) nigrum* (Black Swallow-wort) *Lythrum salicaria* (purple loosestrife), *Lonicera* sp., *Falliopia (Polygonum) japonica* (Japanese knotweed), *Melilotus* sp. and *Vicia cracca* (cow vetch) (Sperduto and Gilman 1995; Natural Heritage Program field forms in Maine, New Hampshire, and Vermont; Anderson 1997).

## **THREATS TO TAXON**

The major threats to *Triantha glutinosa* in New England are the same as for *Carex garberi*. They are reiterated here as applicable:

### ***Disruption of current disturbance regimes***

Since *T. glutinosa* is usually found in areas of ice scour and flooding in New England, disruption of these disturbance regimes could have a major impact. In this regard, dams can significantly affect habitat for *C. garberi* and this taxon. A recent study of hydrologic alteration in the Upper Connecticut River Basin, which includes several sites for *Carex garberi*, showed that present-day impounded rivers have less frequent and lower-magnitude floods compared to free-flowing rivers (Magilligan and Nislow 2000). This same study also showed that at the elevations along the river where the federally-endangered *Astragalus robbinsii* var. *jesupii* is found (elevations similar to at least one *T. glutinosa* occurrence; personal observation), there were smaller differences in flood frequency, but major differences in flood duration (fewer number of days per year the surface was flooded) as compared to free-flowing rivers.

As with *Carex garberi*, dams and their associated hydrologic changes have been associated with the loss of several occurrences of *T. glutinosa*. Although damming of the Connecticut River has had a major impact on river habits, especially floodplain forests, it

appears that *T. glutinosa* can continue to exist under current hydrologic regimes. A number of dams are currently up for re-licensing, however, and rare plant habitat will be considered in this process (Doug Bechtel, personal communication). Significant changes in hydrologic regime could negatively impact distribution and status.

Construction of new dams and stream bank construction activities related to the functioning of the current power plants could also be a threat (e.g., unpublished 1984 data of Rawinski). It is unclear, however, what the threats to this taxon will be should dams be removed from a river system. Although it is intuitive that free-flowing rivers would be beneficial to this taxon and other plant and animal species, the effects of dam removal should be evaluated before any removal occurs.

### ***Adjacent landowner use***

Some occurrences could be affected by adjacent landowner use. Groundwater discharge through seeps is one of the most important factors for maintaining *T. glutinosa*, and any activity that affects groundwater discharge (i.e., drilling of wells, etc.) could also affect *T. glutinosa* populations. Changes to the hydrology and drainage on lands adjacent to sites are difficult to assess and regulate, however; in at least one instance, lands adjacent to a *T. glutinosa* site have been completely developed for some years without causing apparent harm to the plants. Bridge and highway replacement or repairs is also a concern at some sites.

### ***Recreation***

Use of habitat containing *Triantha glutinosa* for recreation -- usually canoeing, swimming, kayaking, camping, or fishing -- is of concern. Since numbers of plants are low at some sites, the plants could be threatened if enough people make recreational use of the shoreline habitat.

### ***Invasive non-native species***

Invasive exotic species pose a possible threat to both *C. garberi* and *T. glutinosa*. Because of the severe disturbance regime associated with high-energy river sites, invasive exotic species may not be able to gain a hold directly in the habitat. Yet the continual deposition of silt provides open soil, often the perfect breeding ground for exotic species invasions. Recent studies of the Connecticut River have inventoried and mapped invasive non-native plants that threaten rare plant populations and natural communities near *T. glutinosa* sites (Anderson 1997). Invasive exotic species are already present at some *T. glutinosa* occurrences (personal observation), and several occurrences on the Connecticut River are near populations of *Fallopia japonica* (*Polygonum cuspidatum*), an invasive species that poses a particular threat to the shores along the river.

### ***Increased atmospheric temperatures***

*Triantha glutinosa* is primarily a northern species reaching the southern limits of its range in the east in New England and the mountains of Appalachia. Global warming could negatively affect this species in New England.

## **DISTRIBUTION AND STATUS**

### ***General status***

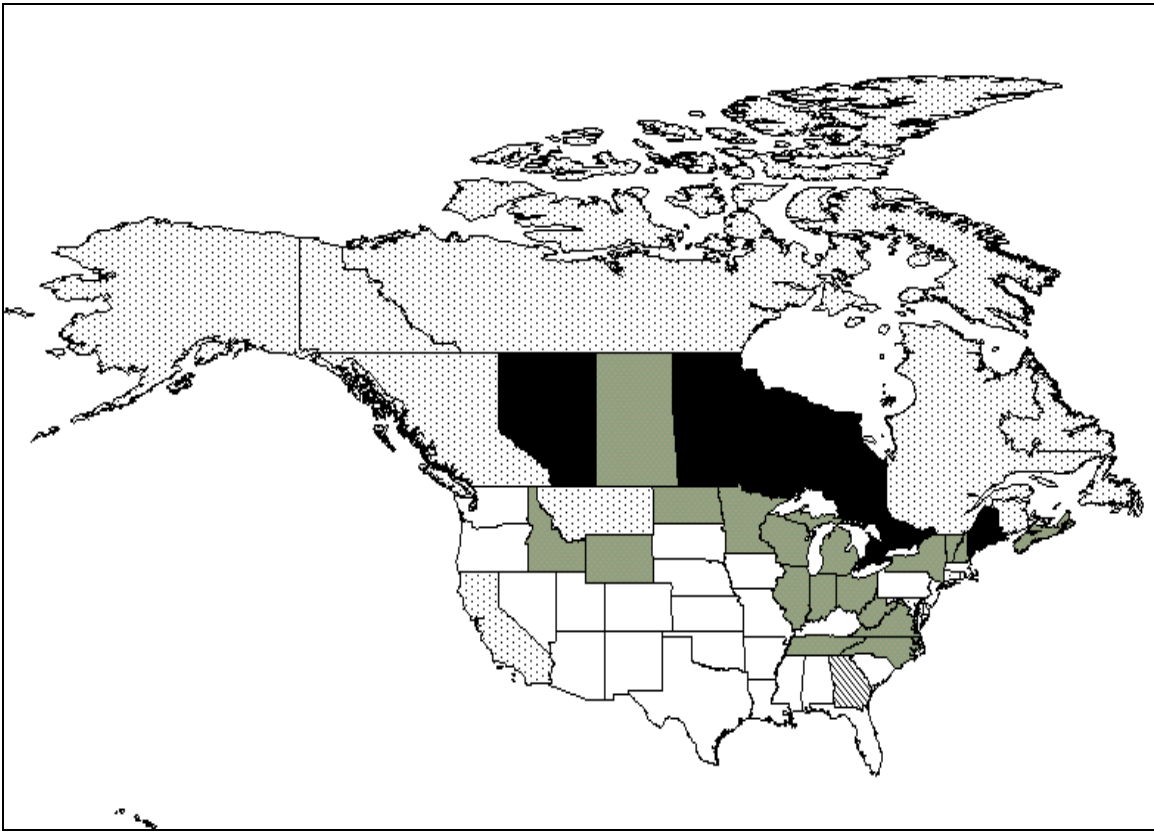
*Triantha glutinosa* is widespread in the United States, occurring from Newfoundland to Alaska south to New York, Indiana, and California and also in the mountains to West Virginia and North Carolina (Gleason and Cronquist 1991, as *Tofieldia glutinosa*) (Figure 4). It is ranked as G5 (NatureServe 2001), indicating a taxon that is widespread, abundant and secure globally, though it may be quite rare in parts of its range, especially at the periphery. Within the Connecticut River watershed, the plant (as *Tofieldia glutinosa*) is ranked W1 (a rare species with 20 or fewer occurrences within the watershed states) by the Silvio O. Conte National Fish and Wildlife Refuge (U. S. Fish and Wildlife Service 1995). In New England, *Triantha glutinosa* is limited to the states of Maine, New Hampshire, and Vermont, roughly the same distribution as *Carex garberi*.

In *Flora Conservanda*: New England (Brumback and Mehrhoff et al. 1996), it is considered Division 3 (locally rare) in New England. Taxa in this division may be common in parts of New England, but have one or more occurrences of biological, ecological, or possible genetic significance. One of these criteria for listing in Division 3 is that the occurrences in a particular state are disjunct to such a degree that genetic isolation is likely (i.e., separated from other populations by more than 50 miles). In this case, occurrences of *Triantha glutinosa* are considered disjunct in Cheshire, Sullivan, and Grafton Counties of New Hampshire, and also disjunct in Windsor, and Caledonia Counties in Vermont. All these disjunct occurrences are located in the Connecticut River watershed.

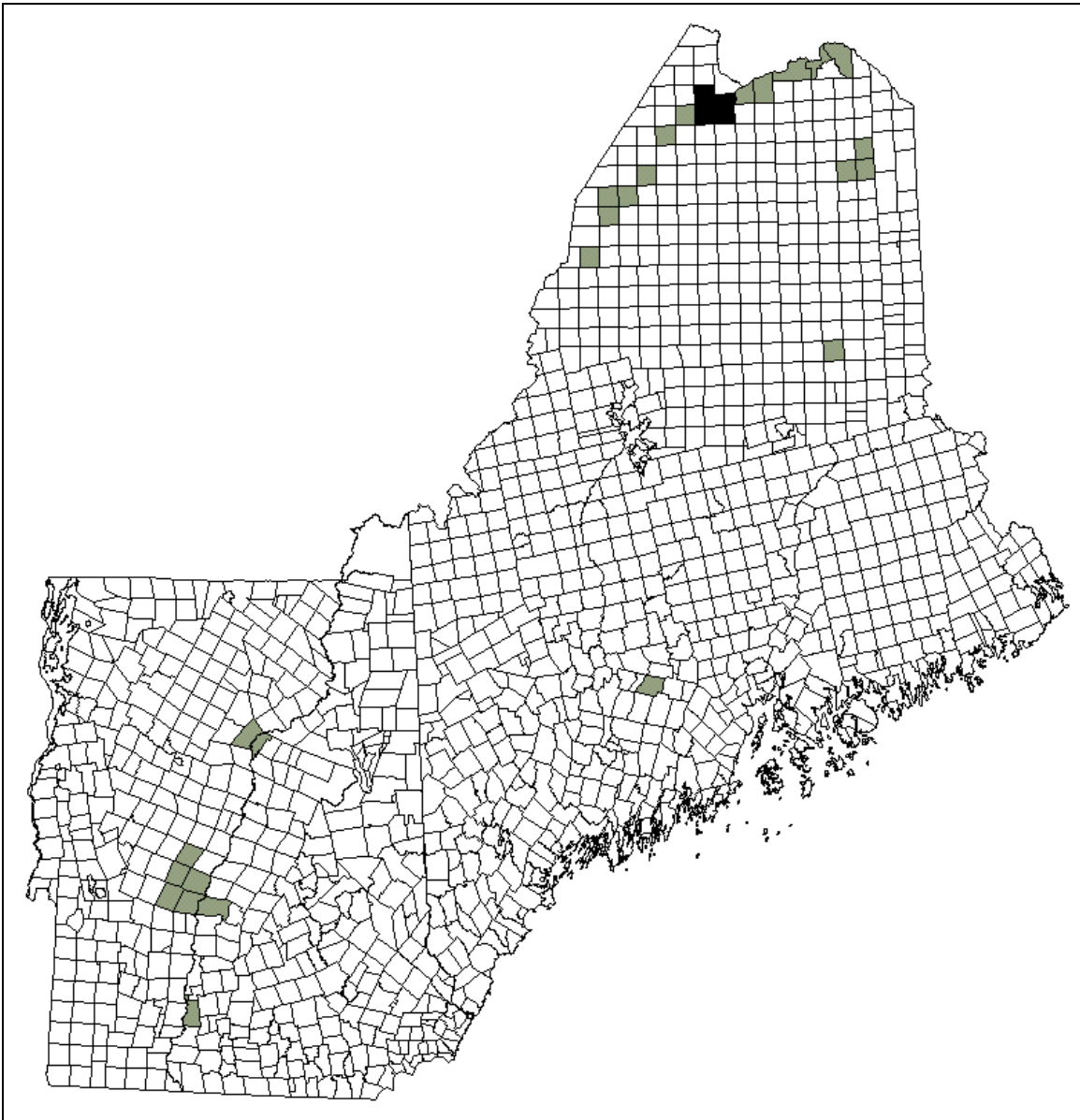
The status of *Triantha glutinosa* in each state and province within its range is given in Table 4. The taxon is considered S1 (critically imperiled) or S2 (imperiled) in 12 states or provinces. Within New England, the plant is considered S1 in both New Hampshire and Vermont, but is considered S3S4 in Maine, where it is no longer being tracked as a rare species. In the states or provinces directly contiguous with New England, *T. glutinosa* is considered S1 in New York, and is listed as SR in both Quebec and in New Brunswick. (Note that although the designation SR is technically used to indicate that there are isolated reports that need verification, in this case "SR" probably indicates that the taxon is listed in floras for these areas, but that it so common that its occurrences are not monitored as a rare species; see Appendix for explanation of state ranks).

<b>Table 4. Occurrence and status of <i>Triantha glutinosa</i> in the United States and Canada based on Information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp;E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Illinois (S2)	Idaho (S?)	Alaska (SR)	Georgia (SH)
Indiana (S2)	Maine (S3S4)	California (SR)	
New Hampshire (S1, T) – 4 extant and 0 historic sites.	Michigan (S?)	Connecticut (SR)	
New York (S1)	Minnesota (S3)	Maryland (SR)	
North Carolina (S1)	Wisconsin (S3)	Montana (SR)	
North Dakota (S1)	Tennessee (SU)	Utah (SRF)	
Ohio (S2)	Alberta (S5)	Washington (SRF)	
Vermont (S1, T) – 5 extant and 2 historic sites.	Manitoba (S5)	British Columbia (SR)	
Virginia (S1)	Ontario (S4?)	Labrador (SR)	
West Virginia (S1)	Saskatchewan (S?)	New Brunswick (SR)	
Wyoming (S2)		Newfoundland (SR)	
Nova Scotia (S1)		Northwest Territories (SR)	
		Quebec (SR)	
		Yukon Territory (SR)	

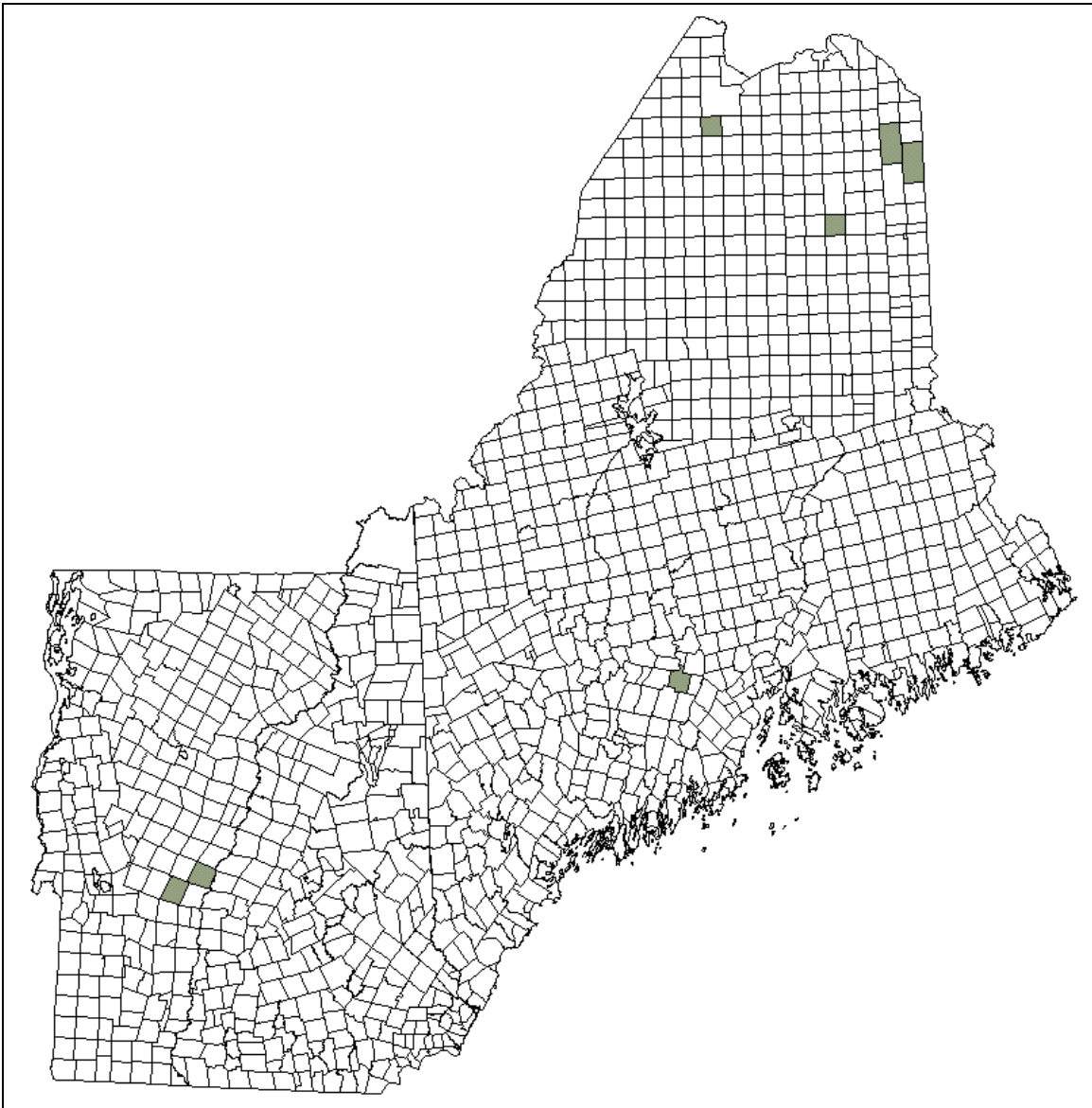




**Figure 4. Occurrences of *Triantha glutinosa* in North America.** States and provinces shaded in gray have one to five (or an unspecified number of) extant occurrences of the taxon. States shaded in black have more than five occurrences. Stippling indicates areas where the taxon is ranked "SR" ("reported;" see Appendix for explanation of NatureServe ranks). The state with diagonal hatching (Georgia) is ranked "SH," where the taxon no longer occurs.



**Figure 5. Extant occurrences of *Triantha glutinosa* in New England.** Towns for Maine, New Hampshire, and Vermont are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.



**Figure 6. Historic occurrences of *Triantha glutinosa* in New England.** Towns shaded in gray have one to five historic records of the taxon.

**Table 5. New England Occurrence Records for *Triantha glutinosa*. Shaded occurrences are considered extant.**

**Note: Maine occurrences are listed under their *former* EO numbers; they are not currently tracked in that state.**

<b>State</b>	<b>EO Number</b>	<b>County</b>	<b>Town</b>
ME	.001	Aroostook	Woodland
ME	.002	Aroostook	Crystal
ME	.003	Aroostook	Allagash
ME	.004	Aroostook	T16 R12 WELS
ME	.005	Aroostook	Allagash
ME	.006	Aroostook	Allagash
ME	.007	Aroostook	Allagash
ME	.008	Aroostook	T15 R13 WELS
ME	.009	Aroostook	Allagash
ME	.010	Aroostook	Crystal
ME	.011	Kennebec	Winslow
ME	.012	Aroostook	St. Francis
ME	.013	Aroostook	Madawaska
ME	.014	Aroostook	Wade
ME	.016	Aroostook	Ft. Fairfield
ME	.017	Aroostook	Caribou
ME	.019	Aroostook	Frenchville
ME	.020	Aroostook	Masardis
ME	.021	Aroostook	Washburn
ME	.022	Aroostook	T12 R15 WELS
ME	.023	Aroostook	T15 R11 WELS

**Table 5. New England Occurrence Records for *Triantha glutinosa*. Shaded occurrences are considered extant.**

**Note: Maine occurrences are listed under their *former* EO numbers; they are not currently tracked in that state.**

<b>State</b>	<b>EO Number</b>	<b>County</b>	<b>Town</b>
ME	.024	Kennebec	Albion
ME	<b>.025</b>	<b>Aroostook</b>	<b>St. John Plt.</b>
ME	<b>.027</b>	<b>Somerset</b>	<b>T9 R17 WELS</b>
ME	<b>.028</b>	<b>Aroostook</b>	<b>T13 R14 WELS</b>
ME	<b>.029</b>	<b>Aroostook</b>	<b>T11 R16 WELS</b>
ME	<b>.030</b>	<b>Aroostook</b>	<b>Allagash</b>
ME	<b>.031</b>	<b>Aroostook</b>	<b>Allagash</b>
ME	<b>.032</b>	<b>Aroostook</b>	<b>Allagash</b>
ME	<b>.033</b>	<b>Aroostook</b>	<b>Ft. Kent</b>
ME	<b>.034</b>	<b>Aroostook</b>	<b>St. Francis</b>
ME	<b>.035</b>	<b>Aroostook</b>	<b>T15 R13 WELS</b>
ME	<b>.036</b>	<b>Aroostook</b>	<b>T16 R12 WELS</b>
ME	<b>.037</b>	<b>Aroostook</b>	<b>St Francis</b>
ME	<b>No #</b>	<b>Aroostook</b>	<b>T12 R16 WELS</b>
NH	<b>.001</b>	<b>Sullivan</b>	<b>Plainfield</b>
NH	<b>.002</b>	<b>Cheshire</b>	<b>Walpole</b>
NH	<b>.003</b>	<b>Grafton</b>	<b>Monroe</b>
NH	<b>.004</b>	<b>Sullivan</b>	<b>Plainfield</b>
VT	<b>.001</b>	<b>Windsor</b>	<b>Hartland</b>
VT	<b>.002</b>	<b>Caledonia</b>	<b>Barnet</b>
VT	<b>.003 includes VT .006 in this EO</b>	<b>Windsor</b>	<b>Pomfret/ Sharon/ Hartford</b>

<p><b>Table 5. New England Occurrence Records for <i>Triantha glutinosa</i>. Shaded occurrences are considered extant.</b></p> <p><b>Note: Maine occurrences are listed under their <i>former</i> EO numbers; they are not currently tracked in that state.</b></p>			
State	EO Number	County	Town
VT	.004	Windsor	Hartford
VT	.005 now part of .007	Windsor	Woodstock
<b>VT</b>	<b>.006 now part of .003</b>	<b>Windsor</b>	<b>Hartford</b>
<b>VT</b>	<b>.007 - .005 is now part of this EO</b>	<b>Windsor</b>	<b>Woodstock</b>

### CURRENT CONSERVATION MEASURES IN NEW ENGLAND

There are several federal laws that directly or indirectly serve to protect *Triantha glutinosa* on river systems in New England, including the U.S. Endangered Species Act. Although this taxon is not listed under this Act, there are at least two federally-listed plants located with or near *Triantha glutinosa* occurrences in two major rivers: *Astragalus robbinsii* var. *jesupii* on the Connecticut River and *Pedicularis furbishiae* on the St. John River. Therefore, proposed dam construction on these two rivers will be scrutinized closely. Re-licensing of dams on the Connecticut River will be similarly reviewed (Doug Bechtel, personal communication). As stated above, however, the U.S. Endangered Species Act does not, however, protect federally listed species on private land. The review processes imposed by The National Environmental Policy Act of 1969 and the Federal Power Act of 1986 may also provide indirect protection for river habitat. (U.S. Fish and Wildlife Service 1995). The Silvio O. Conte National Fish and Wildlife Refuge Act of 1991 establishes a refuge in the Connecticut River watershed of Connecticut, Massachusetts, New Hampshire, and Vermont to protect habitat of this and other rare species.

Each of the three states where *Triantha glutinosa* occurs have laws protecting endangered species. The taxon is officially listed in Vermont (as Threatened) and New Hampshire (as Threatened). It is not listed or tracked as a rare species in Maine.

In Maine, The Nature Conservancy has purchased or is seeking to obtain easements and establish riparian buffers or enable Green Certification on a large amount of land in the upper St. John River watershed (including whole townships in some instances). A large number of occurrences of *Triantha glutinosa* are thus receiving some form of protection. In addition, the Maine Natural Areas Program is working to contact

landowners adjacent to the river about the importance of maintaining the sensitive habitat (Susan Gawler, personal communication). Maine has several laws which protect riverbank habitat to some degree. These laws include the Shoreline Zoning Act as well as a series of articles within the Forest Laws of Maine (Don Cameron, personal communication).

In New Hampshire, one site of *Triantha glutinosa* is owned by New Hampshire TNC. TNC also has a Cooperative Agreement with US GEN at sites along the Connecticut River. US GEN has designated certain areas (including two New Hampshire EOs) as “Special Habitats.” New Hampshire TNC monitors these areas and provides management advice. US GEN intends eventually to donate land it owns on both the New Hampshire and Vermont sides of the river where *Carex garberi* and *Triantha glutinosa* are found to a conservation group or public agency. The Silvio O. Conte National Fish and Wildlife Refuge has been mentioned as a possible recipient.

In Vermont, no law specifically providing buffers along rivers exists, but individual towns often have variable zoning regulations regarding setbacks from rivers. Protection under Act 250 can provide buffer zones to streams and rivers. Several sites in Vermont are on protected land or on land owned by a utility, but at least two sites are under private ownership.

Recreation is considered a threat to some ecologically important habitats in the Connecticut River including at least one site for *Triantha glutinosa* (Anderson 1997). Thus, an outreach brochure for canoeists, kayakers, campers, and other recreational users of the Connecticut River has been developed by TNC to inform users of the location and importance of the rare and vulnerable species and habitats on the islands and other sites (Anderson 1997).

## IV. CONSERVATION OF *TRIANTHA GLUTINOSA*

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### CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Since *Triantha glutinosa* is not considered a rare plant in Maine, and since it seems likely that additional occurrences along river systems in Maine are likely to exist, the general conservation objective for this taxon is to focus on the Connecticut River watershed with a goal of maintaining the current number of extant occurrences there. Past surveys have shown that numbers of plants at an occurrence can fluctuate greatly, however. (This may partly be due to the difficulty of identifying this taxon in its vegetative state.). Therefore, setting goals for numbers of plants at each site is difficult. Furthermore, a number of sites have existed for many years with a relatively small numbers of plants. Since the increasing numbers of plants at high-energy riverside sites is likely to prove difficult, the general objectives for number of plants at a site may need to be revised downward for sites with historically smaller numbers. It should be noted that conservation actions a particular site should be coordinated with conservation planning for other rare plants (i.e., *Carex garberi*, *Rhynchospora capillacea*, etc.) at the site.

Because of its relative abundance in Maine, *Triantha glutinosa* sightings are no longer recorded by the Maine Natural Areas Program. The nine current occurrences in the Connecticut River watershed in New Hampshire and Vermont should be conserved because they are disjunct to such a degree from other occurrences in New England and Canada that genetic isolation is likely. Because of this disjunction, and because large additional areas of suitable habitat are unlikely to be discovered on the Connecticut River, the conservation of these Connecticut River watershed occurrences is the most important objective for the species in New England. In summary, prioritized conservation actions for *Triantha glutinosa* in New England are:

- Maintain the current number of extant occurrences in the Connecticut River watershed (eight).
- A general objective of an average of 100-200 plants for each occurrence, with at least 50-75% of the plants fruiting in a given year, is a reasonable objective for most sites.



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## VI. APPENDICES

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- 1. List of towns where *Carex garberi* and *Triantha glutinosa* co-occur in New Hampshire and Vermont.** Note: only co-occurring sites are listed here; single sites for either taxa are listed in the body of the Conservation and Research Plan)
- 2. An explanation of conservation ranks used by The Nature Conservancy and NatureServe.**

**Appendix 1. List of towns where *Carex garberi* and *Triantha glutinosa* co-occur in New Hampshire and Vermont.** Note: only co-occurring sites are listed here; single sites for either taxa are listed in the body of the Conservation and Research Plan)

<b>Town Name</b>	<b>Co-occurring EOs of <i>Carex garberi</i> and <i>Triantha glutinosa</i></b>	<b>Comments</b>
Plainfield, NH Hartland, VT	<i>Carex garberi</i> NH .001 <i>Triantha glutinosa</i> NH.001 <i>Carex garberi</i> VT.002 <i>Triantha glutinosa</i> VT .001	EOs located in same general area on both sides of the Connecticut River.
Monroe, NH Barnet, VT	<i>Carex garberi</i> NH .002 <i>Triantha glutinosa</i> NH.003 <i>Triantha glutinosa</i> VT .002	EOs located in same general area on both sides of the Connecticut River.
Plainfield, NH	<i>Carex garberi</i> NH .003 <i>Triantha glutinosa</i> NH .004	EOs located at same site on Connecticut River
Walpole, NH	<i>Carex garberi</i> NH .004 <i>Triantha glutinosa</i> NH .002	EOs located at same site on the Connecticut River.
Sharon/Pomfret/ HartfordVT	<i>Carex garberi</i> VT.001 (includes <i>Carex garberi</i> VT.003) <i>Triantha glutinosa</i> VT .003 (includes <i>Triantha glutinosa</i> VT .006)	EOs located along a several mile stretch of the White River.
Woodstock, VT	<i>Carex garberi</i> VT New <i>Triantha glutinosa</i> VT .007 (includes <i>Triantha glutinosa</i> VT .005)	EOs located at same site on the Ottauquechee River.

## 2. An explanation of conservation ranks used by The Nature Conservancy and NatureServe.

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

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

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

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

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

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

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have been 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.