Some Aspects of the Status and Ecology of Seven Rare Wetland Plant Species in the Chicago Region of Northeastern Illinois

Marlin L. Bowles

The Morton Arboretum
Lisle, IL 60532

ABSTRACT

This report examines the Illinois status of seven endangered (E) or threatened (T) wetland plant species considered for listing status changes by the Illinois Endangered Species Protection Board in 1987. During 1988, populations of *Carex atherodes* (E), *C. crawei* (E), *C. rostrata* (E), *Cladium mariscoides* (T), *Eleocharis rostellata* (T), *Galium labradoricum* (T), and *Triglochin palustris* (E) were studied in order to collect voucher specimens, quantify population characteristics, and determine levels of protection and endangerment. These species were found to be obligate wetland species with a wide range of population and associated plant community characteristics. The overall number of known extant populations was increased by more than 200% from 34 to 108, with half of the new records for the sedge *Carex atherodes*; 88% of all populations are now represented by voucher specimens, and 75% of all populations were sampled. A high potential for population loss was found; almost half of the sites examined were endangered or threatened by development or by ecological problems. The number of extant populations was quantified in terms of an Effective Number (N^{-}), which assesses the viability of sites and populations in terms of developmental and ecological threats. Resultant status changes made by the Illinois Endangered Species Protection Board include endangered to threatened for *Carex atherodes* and *Carex crawei*, and delisting from threatened for *Cladium mariscoides*. Based on recent population decline, lack of new populations, and low population numbers, two additional wetland species (*Rhynchospora alba* and *Tofieldia glutinosa*) would appear to qualify for status changes from threatened to endangered.

INTRODUCTION AND PROBLEM

Northeastern Illinois wetlands are highly modified and reduced examples of a once extensive habitat. These remnants still support a unique set of plants and animals, including 69 endangered or threatened Illinois plant species (Bell 1981). Such habitats and their associated species are susceptible to various and subtle ecological changes, and are under severe impact nationally from intensified agriculture and urban land use (Andelin 1984). As a result of increasing development in northeastern Illinois, the listing status of endangered and threatened wetland plant species in this region appears to be in need of review and update.

In 1987, based on a literature and herbarium search, and personal communication, status changes for 71 endangered and threatened (Sheviak 1981) plant taxa were proposed (Bowles 1987) to the Illinois Endangered Species Protection Board. Included in this group were seven species (Table 1) thought to be more abundant than formerly known (Schennum 1980, 1981; Bowles 1987, but which are obligate wetland plants (Wilhelm 1988) in the Chicago region of northeastern Illinois. These species were deferred from status changes because it was felt that available data and voucher specimens were not yet adequate to justify new listings, and that additional field data were needed to help support listing decisions.

The Morton Arboretum was contracted to survey the status of these seven species in northeastern Illinois during the 1988 growing season. Objectives were to 1) document the existence of populations by collecting voucher specimens, 2) estimate plant abundance and size of populations, 3) assess levels

of protection and endangerment for habitats and populations of these species, and 4) develop listing recommendations for these species. An important objective in developing listing recommendations was to develop a method for quantifying habitat and population viability in relation to total numbers of populations. This paper presents a summary of the original report (Bowles 1988) to the Illinois Endangered Species Protection Board.

METHODS

All known Illinois stations for these seven species were determined from the endangered and threatened plant registry cards compiled by the original endangered species project (Sheviak 1981) and updated by the Morton Arboretum (Bowles 1987). During 1988, an attempt was made to visit each site from which populations of these species were reported, and to search for new populations in likely habitats. Procedures included collection of voucher specimens, characterization of natural plant communities (*sensu* White 1978), listing frequent plant associates (*sensu* Swink and Wilhelm 1979), and quantifying population sizes, abundance, and reproductive status of the species in question. Nomenclature follows Swink and Wilhelm (1979).

Populations of *Triglochin palustris* were quantified from continuous adjacent square-meter quadrats along transects; all other species were sampled with square meter quadrats at 5-meter intervals along linear transects through the plant populations. When species occurred in discrete habitats, the sizes of areas occupied by the populations were estimated, based on their length and width. Frequency of each species was determined by presence per 1/4 square meter within each sample quadrat.

Reproductive status was quantified for five species. The numbers of flowering or fruiting culms (individual plants may have multiple culms) were determined per square meter for *Carex atherodes*, *C. rostrata*, and *Cladium mariscoides*, and per single 1/4 square meter in each quadrat for *Carex crawei*; the number of reproductive plants per square meter was determined for *Triglochin palustris*.

A quantitative index was used to aid assessment of the population status of each species. The Effective Number (N^-) of populations of each species was determined in relation to levels or categories of protection and endangerment of each population. In calculating N^-, the current protection status (X_i) of each population was assigned to one of three levels: 1) preserved = dedicated Illinois Nature Preserve, 2) protected = in public or private ownership and recognized as a natural area, or 3) unprotected in public or private ownership. Threats of population endangerment (Y_i) were assigned similar scores: 1) stable = under no apparent threats, 2) threatened = with potential for significant population decline from impact by development, drainage, succession, or exotic species, or 3) endangered = with more immediate potential for population loss by similar conditions. These scores were combined into the Effective Number of Populations (N^-) by the formula:

$$N^- = \text{the sum of } 2/(X_i+Y_i) \text{ over all values of } X_i \text{ and } Y_i,$$

which are the respective protection and endangerment status scores for each site at which the species is extant. For example, the N^- for stable populations within four dedicated nature preserves would be $2/(1+1) \times 4 = 4.0$; while the N^- for four unprotected, endangered populations would be $2/(3+3) \times 4 = 1.333$, an effective number of just over one population.

When making listing recommendations, N^- provides a more realistic index of the number of viable extant populations. Comparison among species of their N^-:N ratios (where N = actual number of sites) represents an expression of their relative levels or threats of endangerment; species with smaller ratios have greater potential for population decline. N^-:N ratios for the above example are $4.0/4.0 = 1$, and $1.33/4.0 = 0.325$ for protected and unprotected species populations, respectively.

In order to make listing recommendations using N^- values, they were applied to the listing criteria used by the original endangered species project (Sheviak 1981), which recommended endangered status for plant species occurring in no more than six localities and likely of becoming extirpated in the near future; threatened species were considered likely to become endangered in the near future. In comparison, the

Illinois Natural Heritage Program state element ranking S1 (5 or fewer occurrences, limited numbers, or vulnerability) is similar to endangered status, while the S2 ranking (6-20 occurrences, limited numbers, or vulnerability) is similar to threatened status.

County voucher specimens are housed currently at the Morton Arboretum (MOR), County duplicates will be sent either to the Illinois State Museum (ISM) or the Illinois Natural History Survey (ILLS). All populations were mapped on copies of 7.5' USGS topographic maps; these maps are maintained in the project files.

RESULTS AND DISCUSSION

Numbers of populations

As a result of this and previous studies (*i.e.* Schennum 1980, 1981; Sheviak 1981; Bowles 1987), 108 extant populations were documented from 72 northern Illinois stations (Table 2) for the seven plant species in question. However, in all cases, the effective number (N^-) of populations for each species was reduced, with values ranging 33-43% less than actual numbers (Table 2). These new records represent an increase of over 200% from the 34 populations known prior to 1981. Ninety-six of the populations were vouchered by specimens, while 83 were sampled for population data (Tables 3 through 9). These discoveries are a product of increased botanical inventories in the Chicago region of Illinois, especially as a result of natural area and wetland preservation and management actions. Also, unusually dry field conditions in 1988 facilitated inventories and discoveries in sites that are normally inundated and difficult to traverse during the growing season. However, these conditions enhanced early senescence of *Carex crawei*, limiting data collection and discoveries of new populations. Similarly, dry panne conditions at Illinois Beach, Lake Co., may have prevented rediscovery of *Triglochin palustris*.

Almost fifty percent of the new records were for the sedge *Carex atherodes*, which is now known to occur in at least 36 stations (with N^-= 20.63) in eight counties (Table 2, Figure 1), an increase from only two historic county records. This plant also is known from a single Shelby County station in central Illinois that was not included in the study. *Carex atherodes* flowers infrequently, but the presence of pubescence on outer leaves and leaf sheaths (Swink and Wilhelm 1979) allows simple field identification of sterile plants, and has facilitated new population discoveries.

The remaining six species all had at least two or more new records (Table 2, Figure 1). *Carex crawei* populations now are known from 15 stations (N^-= 10.23) in six counties; the ten new extant populations included several rediscoveries of historic occurrences. *Carex rostrata* records increased from a single 1981 record in northeastern Illinois to ten populations (N^-= 7.23) in four counties (several reports were found to have been based on misidentification of *Carex vesicaria* var. *monile*). *Cladium mariscoides* was recorded from five new sites, an increase to 14 known extant populations (N^-= 9.23) in three counties. *Eleocharis rostellata* records increased from five stations in three counties to ten extant populations (N^-= 6.56) in four counties. Six new *Galium labradoricum* stations were recorded, with 17 populations (N^-= 10.40) now known extant in three counties. Puff (1977) also indicated a central Illinois record for this bedstraw that could not be mapped on a county basis; the population probably was in Marshall, Peoria, or Tazewell Co., and has not been relocated. *Triglochin palustris* records were increased from four to six known extant populations (N^-= 4.00) in three counties.

Population characteristics

Carex atherodes (Table 3) - As in Iowa (van der Valk and Davis 1979) and Manitoba, (Welling *et al.* 1988), this sedge was found to occupy (and sometimes dominate) zones above the deeper portions of glacial pot-hole marshes, or the borders of floodplain marshes. In Illinois, populations range in area from 10 m^2 to 2700 m^2 (mean = 832.27 m^2). The plant is usually abundant (mean = 79% frequency); it may form monotypic stands or colonies, and can persist in disturbed wetlands. It often occurs with the more frequent *Carex lacustris*. Other common associates in marshes include *Acorus calamus*, *Calamagrostis canadensis*, *Carex haydenii*, *Carex lanuginosa*, *Carex sartwellii*, *Lysimachia thyrsiflora*, *Polygonum amphibium* var. *stipulaceum*, *Polygonum coccineum*, *Sagittaria latifolia*, *Scirpus acutus*, *Scirpus validus* var.

creber, *Sparganium eurycarpum*, *Typha latifolia*, and *Typha angustifolia*. *Carex atherodes* also occurs rarely in sedge meadows, associating with *Calamagrostis canadensis*, *Carex stricta*, *Dryopteris thelypteris* var. *pubescens*, *Galium labradoricum*, and the introduced *Lythrum salicaria*, or in fens with *Calamagrostis canadensis*, *Carex stricta*, *Eupatorium maculatum*, and *Solidago gigantea*.

This is a relatively large perennial sedge; it reproduces vegetatively by rhizomes, and contributes seed bank propagules that germinate during drawdowns (van der Valk and Davis 1979, van der Valk 1981). As a result, annual sexual reproduction probably is unimportant for short-term population maintenance, and was not observed in 32% of the sampled populations. However, flowering culm production reached 8.9 culms/m^2 in some sites, and averaged 1.7 culms/m^2 over 25 populations, suggesting that Illinois populations are contributing to a seed bank.

Carex crawei (Table 4) - This sedge occupies calcareous prairies as well as wetland panne and fen habitats. It reaches its greatest abundance in pannes bordering the foredunes of Lake Michigan, where the plants are abundant (up to 88% frequency) in an extensive habitat. Here, associates include *Carex garberi*, *Eleocharis compressa*, *Juncus balticus* var. *littoralis*, and *Potentilla anserina*. This sedge occupies wet-mesic dolomite prairie in the Des Plaines River Valley, in association with *Deschampsia caespitosa* var. *glauca*, *Eleocharis compressa*, and *Poa compressa*. These populations also may be extensive, especially in disturbance patches, with up to 96% frequencies. *Carex crawei* occurs rarely in mesic prairies, where associates include *Habenaria leucophaea*, *Liatris pycnostachya*, *Panicum virgatum*, *Silphium terebinthinaceum*, and *Solidago riddellii*. In this habitat, it occurs in small to large (75 m^2 - 1300 m^2) colonies, often within disturbance patches, where frequencies may reach 100%. This sedge also is reported from marl flat borders of graminoid fens (G. Wilhelm pers. comm.), but no population data were collected during this study.

Carex crawei is a small, stoloniferous perennial (Fernald 1950) sedge, apparently forming large colonies by this process. Fruiting culms are evidently always present and often abundant (mean = 56 culms/m^2), with extremely high densities (over 200/m^2) in disturbance patches. However, the role of seed production or seed banks in population maintenance is not well known.

Carex rostrata (Table 5) - This is a northern sedge of low nutrient peatlands and lakeshores with relatively stable water levels (Keddy 1983, Lieffers 1984). In Illinois, var. *utriculata* is a rare component of marshes bordering pot-holes, floodplains, sedge meadows, and calcareous floating mats. Most populations are small (1000 m^2 or less in size); however, this sedge is usually very abundant (mean = 83.2% frequency) within populations. Associates are similar in all habitats and include *Acorus calamus*, *Calamagrostis canadensis*, *Carex stricta*, *Carex lacustris*, *Lythrum salicaria* (introduced), *Phragmites communis* var. *berlandieri*, *Polygonum amphibium* var. *stipulaceum*, *Polygonum coccineum*, *Sagittaria latifolia*, *Scirpus fluviatilis*, and *Sparganium eurycarpum*.

As with *Carex atherodes*, *C. rostrata* is a large rhizomatous perennial sedge; its individual shoots live 1-2 years before flowering (Gorham and Somers 1973, Bernard 1976). This species colonizes after fluctuating water levels, or fires, with germination from a seed bank, or after seed dispersal (van Der Valk and Davis 1978, Lieffers 1984, DeBenedetti and Parsons 1984). Flowering/fruiting culms occurred in all Illinois populations sampled (mean = 4.0 culms/m^2), evidently contributing to seed banks.

Cladium mariscoides (Table 6) - The twig-rush is a northern and eastern species of minerotrophic fens and marl flats (Bernard *et al.* 1985) and intermediate exposures along calcareous lakeshores (Keddy 1983). It is an obligate calcareous wetland species in Illinois, occurring in pannes along Lake Michigan, and in calcareous seeps (often association with the marl flats of graminoid fens). It is a dominant (White 1978) and very abundant species of pannes, reaching 100% frequency in extensive linear patterns along beach swales. Associates in this habitat include *Carex buxbaumii*, *Dryopteris thelypteris* var. *pubescens*, *Eriophorum angustifolium*, *Hypericum virginicum* var. *fraseri*, *Juncus balticus* var. *littoralis*, *Lythrum alatum*, *Polygonum amphibium* var. *stipulaceum*, *Scirpus americanus*, and *Triglochin maritima*. *Cladium mariscoides* is a characteristic species of calcareous seeps (White 1978), where it is usually less abundant than in pannes, but may reach

high frequencies locally. In this habitat, frequent associates include *Carex sterilis*, *Dryopteris thelypteris* var. *pubescens*, *Eleocharis rostellata*, *Lysimachia quadriflora*, *Muhlenbergia glomerata*, *Potentilla fruticosa*, *Silphium terebinthinaceum*, *Solidago ohioensis*, *Solidago uliginosa*, *Scirpus acutus*, *Scirpus americanus*, *Scirpus validus* var. *creber*, and *Triglochin maritima*.

Cladium mariscoides is a stoloniferous perennial; populations are maintained through vegetative reproduction (Bernard *et al.* 1985), while seed production contributes to colonization of early successional habitats (Seischab and Bernard 1985). Seed production appears to be high in Illinois populations (mean = 4.2 fruiting culms/m^2); however, these sites are usually stable, and seedling establishment may be important only in disturbed sites.

Eleocharis rostellata (Table 7) - This spike-rush occupies Atlantic coast salt marshes, minerotrophic fens, and nutrient-poor marl flats (Glaser 1983, Seischab *et al.* 1985). In Illinois it is characteristic of calcareous seeps (White 1978), where it is a very abundant (mean = 80.2% frequency) species. Typical associates include *Carex sterilis*, *Cladium mariscoides*, *Eupatorium perfoliatum*, *Lysimachia quadriflora*, *Potentilla fruticosa*, *Scirpus acutus*, *Scirpus validus* var. *creber*, *Solidago ohioensis*, and *Solidago uliginosa*.

Eleocharis rostellata forms tussocks and spreads vegetatively by rooting and proliferating from the tips of sterile culms (Fernald 1950). As in *Cladium mariscoides*, this spike-rush maintains stable populations by vegetative reproduction but colonizes successional marl flats (Seischab and Bernard 1985). Such colonization occurs either by seed dispersal or tip layering of the 1-meter long culms, with seed production indicative of more stressful environments (Seischab and Bernard 1985). Most Illinois populations are typified by layering culms, and apparently occupy more stable habitats.

Galium labradoricum (Table 8) - The northern bedstraw is a rhizomatous (Fernald 1950) diploid species of circumneutral soils (Puff 1977). In Illinois, it is now restricted to three closely related wetland communities in three extreme northeastern counties. Frequencies in these habitats rarely exceed 50%, and plants often are restricted to narrow zones within communities. It occurs locally in calcareous portions of sedge meadows with *Aster puniceus*, *Bromus ciliatus*, *Calamagrostis canadensis*, *Carex stricta*, *Dryopteris thelypteris* var. *pubescens*, *Eupatorium maculatum*, *Galium trifidum*, *Lathyrus palustris*, *Lycopus americanus*, *Lysimachia quadriflora*, *Pycnanthemum virginianum*, *Salix candida*, and *Solidago uliginosa*. It is usually infrequent in calcareous floating mats, associating with *Betula pumila*, *Campanula aparinoides*, *Carex lasiocarpa*, *Carex buxbaumii*, *Dryopteris thelypteris* var. *pubescens*, *Eupatorium maculatum*, *Menyanthes trifoliata* var. *minor*, *Potentilla fruticosa*, *Salix candida*, *Salix pedicellaris* var. *hypoglauca*, *Scirpus americanus*, *Solidago uliginosa*, and *Triglochin maritima*. It occurs rarely in bogs, but was frequent (51% frequency) in one extensive graminoid bog community, associating with *Betula pumila*, *Decodon verticillatus*, *Dryopteris thelypteris* var. *pubescens*, *Drosera intermedia*, *Galium trifidum*, *Lathyrus palustris*, *Liparis loeselii*, *Potentilla palustris*, *Salix candida*, *Salix pedicellaris* var. *hypoglauca*, *Scirpus acutus*, *Sphagnum* sp., and *Vaccinium macrocarpon*.

Triglochin palustris (Table 9) - Although reported from Lake Co. pannes along Lake Michigan, during this study the slender bog arrow grass was found only in calcareous seeps, where it is a characteristic plant (White 1978). In this habitat, it is infrequent to abundant (mean = 42% frequency) in usually small (mean = 12.7 m^2) areas of open spring runs. Most associates are more typical of adjacent calcareous seep vegetation, and include *Carex hystricina*, *Carex viridula*, *Deschampsia caespitosa* var. *glauca*, *Eleocharis elliptica*, *Equisetum arvense*, *Juncus brachycephalus*, *Parnassia glauca*, *Potentilla fruticosa*, *Rhynchospora capillacea*, *Scirpus acutus*, *Solidago ohioensis*, and *Tofieldia glutinosa*. This perennial spreads vegetatively by bulb-bearing stolons (Fernald 1950), with reproductive plants reaching densities of over 14 stems/m^2.

STATUS AND LISTING RECOMMENDATIONS

Wetland status

By 1981, 62% of the remaining high-quality examples of northeastern Illinois wetlands were threatened with modification or destruction (Bell 1981). During the 1980's these impacts have

continued and are now escalating in the rapidly developing Chicago region of Illinois. Wetlands receive some protection from development through Army Corps of Engineers and Environmental Protection Agency regulations. However, total watershed protection is not provided, and the majority of permit applications are not denied. The amended Illinois Endangered Species Protection Act now requires agency consultation on permit applications involving state-listed species, but agreements are not binding.

Among the 72 sites examined during this study, only 23 (32%) are dedicated Illinois Nature Preserves, while 19 sites remain totally unprotected from development (Table 2). In addition, over half (54.2%) of all sites examined (including at least seven Nature Preserves) are either threatened or endangered with drainage, development, succession due to fire protection, or invasion by exotic species such as *Lythrum salicaria*, *Phalaris arundinacea*,or *Rhamnus frangula*, . Also, threats to wetland sites often can impact suites of endangered or threatened species. Over one-third of all sites examined supported two or more of the seven species studied here, in addition to other listed species that were not studied. For example, alteration of a Kendall Co. graminoid fen resulted in apparent loss of the co-occurring species *Eleocharis rostellata* and *Triglochin palustris*, along with the state-listed *Mimulus glabratus* var. *fremontii*.

The management and protection needs of endangered or threatened obligate wetland species should be considered when developing listing-criteria for these species. Populations that occur in habitats with poor protection and management, or with development and ecological threats, have lowered viability, requiring protection of a relatively greater number of habitats to insure species survival. Under these conditions, calculation of an effective number of populations (N^{-}) provides quantitative support in assigning species to an appropriate current listing status category. When N^{-} is used association with qualitative evaluations, it can provide a more useful and defendable assessment of species-listing status.

Population status and listing recommendations

In response to original listing status recommendations (Bowles 1987), and the additional information provided in the initial status report on the seven wetland species (Bowles 1988), the Illinois Endangered Species Protection Board updated the Illinois list of endangered and threatened plant species in 1989 (Illinois Endangered Species Protection Board 1989). The Board also made subsequent listing changes for several species considered in this paper. These new listings are summarized below and in Table 2; county distribution maps are provided in Figure 1.

Carex atherodes - Although at least 36 populations of this sedge are now known, the effective number of populations is $N^{-} = 20.63$, with the lowest N^{-}:N ratio among species reviewed here. Six sites are dedicated Nature Preserves, and 20 of the 36 known stations are threatened or endangered by destruction, woody plant succession, or invasion by the exotics *Lythrum salicaria*, *Phalaris arundinacea*, and *Rhamnus frangula*. At least ten Chicago region stations have been proposed for development; as a result, N^{-} could drop below 20.0 in the near future. Because of the high number of known populations, the Illinois Endangered Species Protection Board removed this species from listing as endangered. It was retained as threatened because of the inordinately high number of populations under ecological or developmental threats.

Carex crawei - Only five of the known 15 populations of this sedge are protected as Nature Preserves, and six populations are threatened or endangered from woody succession, drainage, flooding, or development. As a result, the effective number of populations is $N^{-} = 10.23$. Although it remains somewhat widespread, this small plant is rare and often found only in small colonies. The pannes and dolomite prairies supporting larger populations of this sedge are restricted to Lake Co., and the Des Plaines River Valley of DuPage, Kankakee, and Will counties, respectively. This sedge was removed from listing as endangered because of the increase in number of known populations and large sizes of some populations. However, it was retained as a threatened species because of its overall rarity, lack of site protection, and ecological threats to many populations.

Carex rostrata - Variety *utriculata* is restricted to four counties in northeastern Illinois, where populations are usually small, and occur in a single natural

community. Extant records for this sedge were increased from one to ten populations and nine of the Illinois stations are protected. However, the effective number of populations is $N^{-} = 7.23$ because of widespread ecological threats such as from purple loosestrife, drainage, and fire protection. Although the number of known populations was increased, the Illinois Endangered Species Protection Board maintained listing of this species as endangered because of its usual small population size, restriction to a single community type, and ecological threats.

Cladium mariscoides - This sedge is restricted to three extreme northeastern Illinois counties, with fifteen known extant records. The majority of populations are protected and stable, and an extensive community dominant population occurs in pannes along Lake Michigan. The effective number of populations was reduced to $N^{-} = 9.23$ because of threats to some populations. The Illinois Endangered Species Protection Board removed this species from listing as threatened because of the high number and large size of protected populations.

Eleocharis rostellata - Although only three of the ten Illinois populations are within dedicated Nature Preserves, most appear stable, and the effective number of populations is $N^{-} = 6.56$. Because of the large number of apparently stable populations, this species was maintained by the Illinois Endangered Species Protection Board as threatened. However, most populations are small and restricted to a fragile habitat dependent upon proper management and stable, pollution-free, minerotrophic, ground water. As a result, effective or actual population sizes could be easily reduced in the near future, and the status of this species should be monitored frequently. For example, a population at an unmanaged Kendall Co. station was lost since 1977 after successional changes.

Galium labradoricum - This bedstraw is restricted to a specific micro-habitat in only three Illinois counties. Although more than 80% of the 17 populations are protected, the effective number is low ($N^{-} = 10.4$) because over 70% of the stations are threatened or endangered with impacts that could result in population loss. Habitat invasion by *Lythrum salicaria* is a major problem, while invasion by *Rhamnus frangula* is a threat to disturbed or unmanaged sites. As a result, this species was retained as a threatened species.

Triglochin palustris - Five of the six known stations ($N^{-} = 4.0$) for this species are either protected or are in relatively stable condition. However, the total area of spring-run habitat occupied by this species is extremely small and very fragile, and population maintenance appears dependent upon a continuous supply of unpolluted minerotrophic groundwater. One unmanaged Kendall Co. population was recently lost after successional changes. As a result, this species was retained as state endangered.

Additional recommended status changes

Two additional species were recommended for listing changes from threatened to endangered because of their obligate wetland status, lack of newly reported populations, recent apparent loss of populations, and relatively low effective population numbers (Bowles 1988). Although the Illinois Endangered Species Protection Board (1989) retained these species as threatened, it is recommended that their status be reviewed frequently to determine if population loss or decline is occurring.

Rhynchospora alba - This obligate wetland species (Wilhelm 1988) occurs in sphagnum bogs, graminoid fens, and pannes, with seven modern stations ($N^{-} = 4.73$) known from three Illinois counties (Sheviak 1981) and no new records. One site record (Thornton-Lansing Woods Nature Preserve, Cook Co.) is not represented by a voucher specimen, and a second site (Cedar Lake Bog Nature Preserve, Lake Co.) has declined in natural quality and may no longer maintain this species.

Tofieldia glutinosa - The false asphodel is an obligate wetland species (Wilhelm 1988) of fens and pannes in four counties (Sheviak 1981). It is extant at seven stations ($N^{-} = 5.50$) in Illinois, and no new populations have been reported. It has not been relocated at Braidwood Sand Prairie Nature Preserve, Will Co., nor at the South Elgin Sedge Meadow, Kane Co. station, which has been degraded by peat mining, drainage, and invasion by *Lythrum salicaria*.

ACKNOWLEDGMENTS

I thank Sue Lauzon and the Illinois Endangered Species Protection Board for assistance in project funding. A large portion of this study was based on initial site records and subsequent field assistance contributed by Wayne Schennum (McHenry Co. Conservation District) and Wayne Lampa (Forest Preserve District of DuPage Co.). Other people who provided essential information and assistance during 1988 include Dan Brouillard and Dennis Laurie (Lake Co. Forest Preserve District), Gerould Wilhelm and Jeff Mengler (The Morton Arboretum), Randy Nyboer (Illinois Department of Conservation), Marcy DeMauro (Will Co. Forest Preserve District), Mitch Adamus (Fermi Lab), Robert F. Betz, (Northeastern Illinois University), Gary Horn (Nature Conservancy Volunteer Stewardship Program), and Ken Klick (Indiana Dunes National Lakeshore). Michael Stieber provided a literature search from the Morton Arboretum Library. I thank these people for their assistance without which this study could not have been accomplished. This report was extensively reviewed and improved by Marcy DeMauro, Wayne Lampa, Jeff Mengler, Victoria Nuzzo, Wayne Schennum, Floyd Swink, and Gerould Wilhelm.

LITERATURE CITED

Andelin, J. 1984. Wetlands, their use and regulation. U.S. Congress Office of Technology Assessment, OTA-0-206, Washington, D.C.

Bell, H. 1981. Illinois wetlands, their value and management. Illinois Institute of Natural Resources Document No. 81/33, Chicago.

Bernard, J.M. 1976. The life history and population dynamics of shoots of *Carex rostrata*. Journal of Ecology 64: 1045-1048.

Bernard, J.M., F.K. Seischab, and G. Jacoby. 1985. The history and production of above- and below-ground structures of *Cladium mariscoides* (Muhl.) Torr. in a western New York fen. The Bulletin of the Torrey Botanical Club 112: 288-294.

Bowles, M.L. 1987. Illinois endangered and threatened plants: nomenclatural and taxonomic changes, new taxa for review as endangered or threatened, and recommended status changes for listed flora. Unpublished report to the Illinois Endangered Species Board. The Morton Arboretum, Lisle, IL.

Bowles, M.L. 1988. The status of seven wetland plant species in northeastern Illinois. Unpublished report of listing recommendations to the Illinois Endangered Species Protection Board. The Morton Arboretum, Lisle, IL.

DeBenedetti, S.H. and D.J. Parsons. 1984. Postfire succession in a Sierran subalpine meadow. American Midland Naturalist 111: 118-125.

Fernald, M.L. 1950. Gray's manual of botany. Eighth Edition. American Book Co., New York.

Glaser, P.H. 1983. *Eleocharis rostellata* and its relation to spring fens in Minnesota. The Michigan Botanist 22:19-21.

Gorham, E. and M.G. Somers. 1973. Seasonal changes in the standing biomass of two montane sedges. Canadian Journal of Botany 51:1097-1098.

Illinois Endangered Species Protection Board. 1989. Checklist of endangered and threatened animals and plants of Illinois. Illinois Department of Conservation, Springfield.

Keddy, P.A. 1983. Shoreline vegetation in Axe Lake, Ontario: effects of exposure on zonation patterns. Ecology 64:331-344.

Lieffers, V.J. 1984. Emergent plant communities of oxbow lakes in northeastern Alberta, Canada: salinity, water-level fluctuation, and succession. Canadian Journal of Botany 62: 310-316.

Puff. C. 1977. The *Galium obtusum* group *Galium* section *aparinoides* Rubiaceae. Bulletin of the Torrey Botanical Club 104; 202-208.

Seischab, F.K, and J.M. Bernard. 1985. Early plant succession on marl beds in the Byron-Bergen Swamp. Bartonia 51:58-64.

Seischab, F.K., J.M. Bernard, and K. Fiala. 1985. Above- and belowground standing crop partitioning of biomass by *Eleocharis rostellata* Torr. in the Byron-Bergen Swamp, Genesee County, New York. American Midland Naturalist 114:70-76.

Schennum, W. 1980. A natural areas inventory of Long Grove, Lake Co., IL. Unpublished report. Natural Land Institute, Rockford, IL.

Schennum, W. 1981. Ecological assessment of Citizens for Conservation properties, Barrington, Illinois. Unpublished report.

Sheviak, C.J. 1981. Endangered and threatened plants. In Bowles, M.L., V.E. Diersing, J.E. Ebinger, and H.C. Schultz, editors, Endangered and threatened vertebrate animals and vascular plants of Illinois. Illinois Department of Conservation, Springfield, and Natural Land Institute, Rockford, IL.

Swink, F. and G. Wilhelm. 1979. Plants of the Chicago region. The Morton Arboretum, Lisle, IL.

van der Valk, A.G. 1981. Succession in wetlands: a Gleasonian approach. Ecology 62:688-696.

van der Valk, A.G. and C.B. Davis. 1978. The role of seed banks in the vegetation dynamics of prairie glacial marshes. Ecology 59:322-335.

van der Valk, A.G. and C.B. Davis. 1979. A reconstruction of the recent vegetational history of a prairie marsh, Eagle Lake, Iowa, from its seed bank. Aquatic Botany 6:29-51.

Welling, C.H., R.L. Pederson, and A.G. van der Valk. 1988. Recruitment from the seed bank and the development of zonation of emergent vegetation during a drawdown in a prairie wetland. Journal of Ecology 76:483-496.

White, J. 1978. Technical report, Illinois natural areas inventory. Department of Landscape Architecture, University of Illinois, Urbana-Champaign, and Natural Land Institute, Rockford, IL.

Wilhelm, G. 1988. Chicago region flora, National list of wetland plant categories. Unpublished report by the Morton Arboretum.

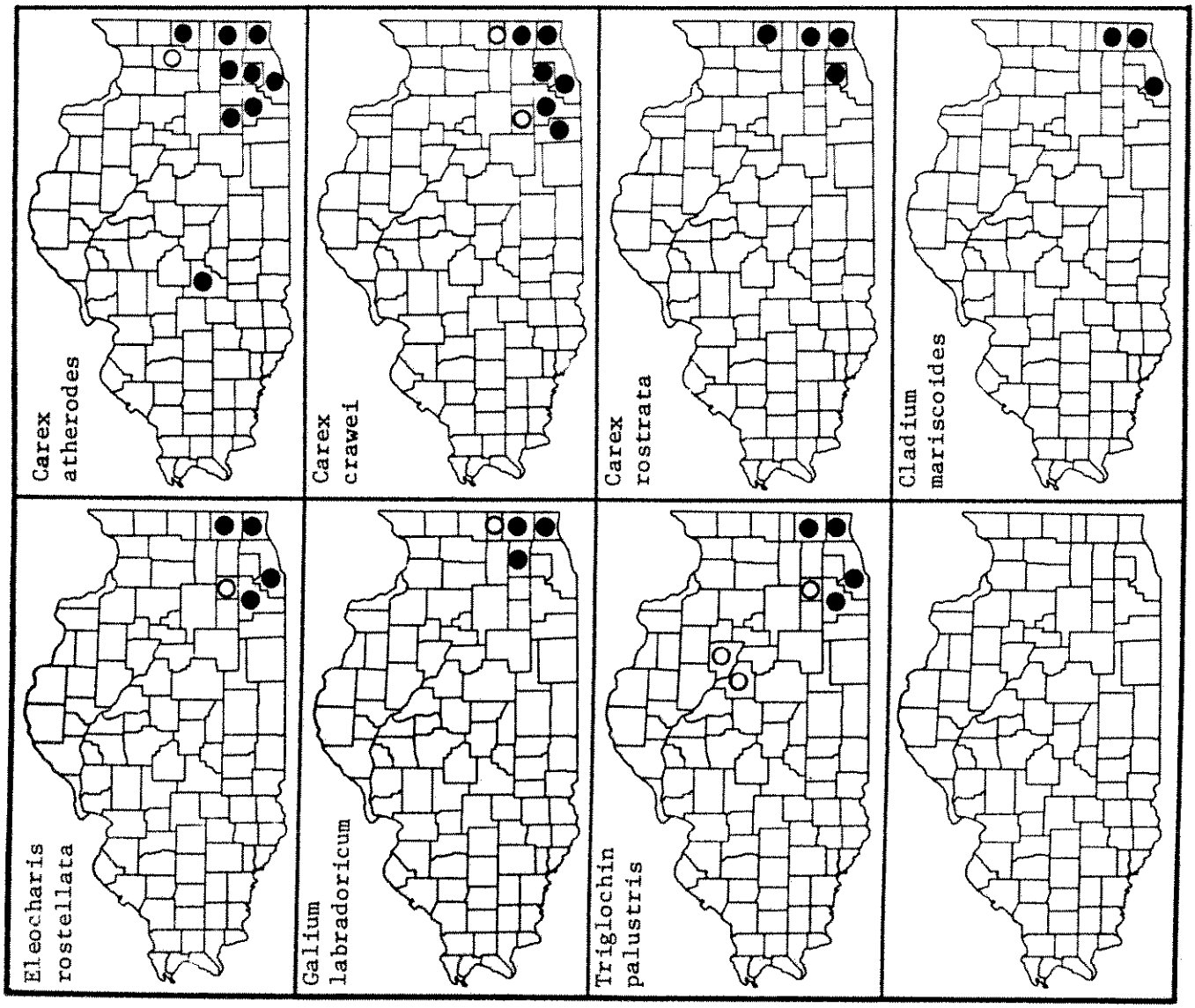

Figure 1. Illinois distributions of seven wetland plant species.
Closed circle = population(s) extant
Open circle = population(s) presumed extirpated

Table 1. Original listing status prior to field study for seven wetland plant species of the Chicago region of northeastern Illinois.

SPECIES AND VARIETY	ORIGINAL STATUS
Carex atherodes Spreng.	Endangered
Carex crawei Dew.	Endangered
Carex rostrata Stokes var. *utriculata* (Boott) Bailey	Endangered
Cladium mariscoides (Muhl.) Torr.	Threatened
Eleocharis rostellata Torr.	Threatened
Galium labradoricum Wieg.	Threatened
Triglochin palustris L.	Endangered

Table 2. Summary of current status and threats, known extant records (N) in 1981 (Sheviak 1981), effective numbers of populations (N^-), and current and recommended listing status for seven wetland species proposed for status changes.

CATEGORY	Carex atherodes	Carex crawei	Carex rostrata	Cladium mariscoides	Eleocharis rostellata	Galium labradoricum	Triglochin palustris	[TOTAL]	(%)
Extant records (1981)	0	5	1	9	5	9	4	[33]	(30)
Populations (1988)									
Preserved populations	6	5	5	4	3	9	2	[34]	(31)
Protected populations	17	8	4	7	6	5	3	[50]	(46)
Unprotected populations	13	2	1	3	1	3	1	[24]	(22)
Stable populations	16	9	6	7	4	5	3	[50]	(46)
Threatened populations	11	3	3	5	6	6	2	[36]	(33)
Endangered populations	9	3	1	2	0	6	1	[22]	(20)
Confirmed by voucher (1988)	33	12	10	12	9	14	6	[96]	(88)
Sampled in 1988	25	9	9	10	9	14	6	[82]	(75)
Total extant populations (1988)	36	15	10	14	10	17	6	[108]	
Effective numbers of populations (N^-)	20.63	10.23	7.23	9.23	6.56	10.40	4.00		
Ratio of N^-:N	0.57	0.68	0.72	0.66	0.66	0.61	0.67		
Original listing (Sheviak 1981)	Endangered	Endangered	Endangered	Threatened	Threatened	Threatened	Endangered		
Final listing (Endangered Species Protection Board)	Threatened	Threatened	Endangered	Delisted	Threatened	Threatened	Endangered		

Table 3. Area, frequency, and density for 25 *Carex atherodes* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on m^2 quadrats; all data were collected at 5-meter intervals along linear transects through *C. atherodes* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per 1/4m^2	Culm density per m^2 (+-sd)
DuPage/#1	2500 m^2 (21)	83.3%	4.9/m^2 (5.3)
DuPage/#2	525 m^2 (10)	100%	2.3/m^2 (3.6)
DuPage/#3	260 m^2 (5)	100%	0.0/m^2
DuPage/#4	25 m^2 (5)	25%	0.0/m^2
DuPage/#5	2000 m^2 (24)	45.8%	0.0/m^2
DuPage/#6	30 m^2 (6)	45.8%	5.0/m^2 (4.5)
DuPage/#7	1600 m^2 (8)	100%	0.4/m^2 (0.5)
DuPage/#8	364 m^2 (5)	100%	5.6/m^2 (4.3)
Grundy/#1	500 m^2 (6)	95.5%	1.2/m^2 (2.3)
Kane/#1	2000 m^2 (10)	97.7%	2.8/m^2 (4.4)
Lake/#1	300 m^2 (10)	45%	0.4/m^2 (1.0)
Lake/#2	400 m^2 (10)	92.5%	0.5/m^2 (0.7)
Lake/#3	190 m^2 (5)	70%	2.2/m^2 (3.3)
Lake/#4	2000 m^2 (20)	70%	2.2/m^2 (3.3)
Lake/#5	2700 m^2 (18)	55.5%	0.0/m^2
Lake/#6	300m^2 (12)	81.25%	0.7/m^2 (1.6)
Lake/#7	2500 m^2 (13)	90.4%	0.4/m^2 (1.1)
Lake/#8	10 m^2 (3)	100%	0.0/m^2
Lake/#9	300 m^2 (6)	96.4%	8.9/m^2 (5.9)
Lake/#10	500 m^2 (5)	45%	0.0/m^2
Lake/#11	500 m^2 (10)	52.2%	2.2/m^2 (3.9)
McHenry/#1	150 m^2 (5)	100%	1.6/m^2 (1.4)
McHenry/#2	400 m^2 (5)	92%	0.0/m^2
McHenry/#3	15 m^2 (4)	100%	2.0/m^2 (4.0)
Winnebago/#1	750 m^2 (10)	100%	0.0/m^2
Column means	832.7 m^2	79.3%	1.7/m^2
Standard deviations	(900.30)	(24.0)	(2.0)

Table 4. Area, frequency, and density for 10 *Carex crawei* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on single 1/4 m^2 quadrats within each m^2 quadrat. All data were collected at 5-m intervals along linear transects through *C. crawei* populations. No. of plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per 1/4m^2	Density per 1/4m^2 (+-sd)
Cook/#1	1300 m^2 (15)	65%	5.5 (10.1)
DuPage/#1	1000 m^2 (10)	53%	16.2 (16.8)
DuPage/#2	500 m^2 (4)	100%	50.2 (38.2)
DuPage/#3	1250 m^2 (3)	100%	6.3 (6.7)
DuPage/#4	75 m^2 (2)	88%	21.5 (13.4)
Lake/#1	1000 m^2 (6)	88%	7.8 (7.4)
Lake/#2	125,000 m^2 (19)	77.6%	7.3 (8.1)
Will/#1	10,000 m^2 (6)	96%	15.2 (30.9)
Will/#2	1000 m^2 (5)	65%	6.4 (8.6)
Will/#3	700 m^2 (6)	63%	3.2 (3.6)
Column means	14,182.5 m^2,	79.6%	14.0
Standard deviations	(39,044.9)	(17.2)	(14.0)

Table 5. Area, frequency, and density for 9 *Carex rostrata* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on m^2 quadrats. All data were collected at 5-m intervals along linear transects through *C. rostrata* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per 1/4m^2	Culm density per m^2 (+-sd)
DuPage/#1	500 m^2 (8)	88.95%	2.4/m^2 (2.8)
DuPage/#2	100 m^2 (5)	100%	1.5/m^2 (1.1)
Lake/#1	1000 m^2 (8)	75%	8.15/m^2 (9.9)
Lake/#2	25 m^2 (7)	100%	10.1/m^2 (6.0)
McHenry/#1	15 m^2 (4)	100%	4.25/m^2 (2.5)
McHenry/#2	10 m^2 (4)	75%	1.75/m^2 (2.9)
McHenry/#3	5000 m^2 (10)	90%	2.7/m^2 (2.2)
McHenry/#4	1000 m^2 (11)	100%	4.3/m^2 (2.0)
McHenry/#5	1000 m^2 (15)	20%	0.5/m^2 (1.4)
Column means	961.1 m^2	83.2%	4.0/m^2
Standard deviations	(1579.1)	(25.9)	(3.2)

Table 6. Sample size, frequency, and density for 11 *Cladium mariscoides* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based in m^2 quadrats. All data were collected at 5-meter intervals along linear transects through *C. mariscoides* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Transect length & No. m^2 plots	Frequency per 1/4m^2	Culm density per m^2 (+-sd)
Cook/#1	110 m (22)	59%	2.8/m^2 (4.3)
Lake/#1	50 m (10)	80%	4.1/m^2 (3.7)
Lake/#2	75 m (15)	100%	7.5/m^2 (5.5)
Lake/#3	50 m (10)	50%	2.7/m^2 (5.8)
Lake/#4	50 m (10)	20%	0.8/m^2 (1.9)
Lake/#5	50 m (10)	80%	7.5/m^2 (9.3)
McHenry/#1	50 m (10)	50%	6.0/m^2 (11.4)
McHenry/#2	75 m (13)	85%	11.6/m^2 (15.8)
McHenry/#3	10 m (3)	100%	1.3/m^2 (0.6)
McHenry/#4	50 m (11)	50%	1.3/m^2 (2.2)
McHenry/#5	50 m (11)	55%	1.7/M^2 (2.4)
Column means	56.3 m	66.3%	4.2/m^2
Standard deviations	(24.50)	(24.7)	(3.4)

Table 7. Sample size and frequency for 8 *Eleocharis rostellata* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats); all data were collected at 5-meter intervals along linear transects through *E. rostellata* populations. Standard deviations are given in parentheses.

County/area	Transect length	No. of m^2 plots	Frequency per 1/4 m^2
Cook/#1	110 m	10	87.5%
Lake/#1	50 m	10	77.5%
Lake/#2	10 m	4	70%
Lake/#3	5 m	2	87.5%
McHenry/#1	75 m	15	60%
McHenry/#2	50 m	10	87.5
McHenry/#3	50 m	40	90%
Will/#1	25 m	5	85%
Column means	46.9 m		80.2%
Standard deviations	(34.6)		(10.4)

Table 8. Sample size and frequency for 14 *Galium labradoricum* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats); all data were collected at 5-meter intervals along linear transects through *G. labradoricum* populations. Standard deviations are given in parentheses.

County/area	Transect length	No. of m^2 plots	Frequency per 1/4 m^2
Kane/#1	50 m	10	42.5%
Lake/#1	50 m	10	50%
Lake/#2	75 m	15	35%
Lake/#3	75 m	15	23%
Lake/#4	50 m	10	47.5%
Lake/#5	50 m	10	55%
Lake/#6	100 m	20	24%
Lake/#7	25 m	5	10%
Lake/#8	100 m	20	22.5%
McHenry/#1	50 m	10	10%
McHenry/#2	125 m	27	51%
McHenry/#3	150 m	32	37.5%
McHenry/#4	75 m	15	28.3%
McHenry/#5	50 m	10	27.5%
Column means	73.2 m		33.1%
Standard deviations	(34.6)		(14.7)

Table 9. Area, frequency, and density for 6 *Triglochin palustris* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats) and density is based on m^2 quadrats; all data were collected at 5-meter intervals along linear transects through *T. palustris* populations. No. of plots and standard deviations are given in parentheses.

County/area	Population area (No. m^2 plots)	Frequency per 1/4 m^2	Stem density per m^2 (+-sd)
Cook/#1	6 m^2 (6)	25%	7.0/m^2 (15.1)
McHenry/#1	7 m^2 (7)	71.4%	14.4/m^2 (17.1)
McHenry/#2	38 m^2 (38)	26.3%	7.0/m^2 (15.1)
McHenry/#3	4 m^2 (4)	37.5%	4.5/m^2 (3.8)
McHenry/#4	8 m^2 (8)	65.6%	12.4/m^2 (13.2)
Will/#1	13 m^2 (8)	26.9%	3.15/m^2 (3.4)
Column means	12.7 m^2	42.0%	7.0/m^2
Standard deviations	(12.8)	(21.1)	5.3