# *Conservation Assessment*

# *For*

# *Eastern Blue-eyed-grass (Sisyrinchium atlanticum)*

***USDA Forest Service, Eastern Region***
2003

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*This document is undergoing peer review, comments welcome*

*This Conservation Assessment was prepared to compile the published and unpublished information and serves as a Conservation Assessment for the Eastern Region of the Forest Service.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

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## EXECUTIVE SUMMARY

The National Forest Management Act and U.S. Forest Service policy requires that Forest Service lands be managed to maintain viable populations of all native plant and animal species. A viable population is one that that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its range within a given planning area (FSM 2670.5.22) (Brzeskiewicz, 2000).

This Conservation Assessment provides a review of the taxonomy, life history, habitat, distribution, and population viability for *Sisyrinchium atlanticum* E. P. Bicknell, and potential threats to it within Region 9. The body of information within this report comes from literature review, personal and written communication with state, federal, academic, and consulting botanists, and examination of specimens at the University of Michigan herbarium.

Region 9 is comprised of 20 states and 15 National Forests. The states include Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin. The National Forests include Allegheny, Chequamegon/Nicolet, Chippewa, Green Mountain/Finger Lakes, Hiawatha, Hoosier, Huron-Manistee, Mark Twain, Midewin (National Tallgrass Prairie), Monongahela, Ottawa, Shawnee, Superior, Wayne, and White Mountain.

*Sisyrinchium atlanticum* has been assigned a state status of endangered in Illinois, Pennsylvania, and Ohio and threatened in Michigan. It has a state rank of critically imperiled (S1) in Illinois and Pennsylvania, imperiled (S2) in Missouri; rare or uncommon (S3) in Delaware, and an historical occurrence (SH) in Vermont. It is assigned a global rank of G4G5 and is considered globally secure. The species is a Regional Foresters Sensitive Species (R9) in the Huron-Manistee and Green Mountain National Forests.

## INTRODUCTION

The highest frequency of occurrence of *S. atlanticum* in the United States is along the eastern coastline and in the southeast. Reznicek (1994) considers *S. atlanticum* a coastal plain disjunct in the Great Lakes region. The populations in this region are generally small, often occurring in small isolated wetland habitats. Yatskievych (1999) indicates that it is uncommon in the Mississippi Lowlands Division and disjunct at a few sites in the Ozark Division of Missouri. Steyermark (1963, cf. Yatskievych, 1999) cited it as an example of a coastal plain relict. Seymor (1982) lists it as abundant along the New England coastline becoming sparse towards the west. Radford et al. (1968) listed it as common throughout the southeastern United States.

It is probable that *S. atlanticum* has always been uncommon to rare in the states west and north of the Atlantic and Gulf Coastal Plain. It often occurs with other disjuncts that are also rare in these regions. There is insufficient data to assess the effects that environmental, demographic, and genetic stochasticity, natural catastrophes, and anthropogenic activities may have upon the species. Although apparently secure as a species, additional surveys to determine the frequency of occurrence and size of populations are needed, particularly within those regions where it is considered disjunct. Additional research on the biological and

ecological parameters that dictate its presence should be considered as well as implementation of measures to protect extant populations.

## NOMENCLATURE AND TAXONOMY

*Sisyrinchium atlanticum* is a member of the:
**Genus:** *Sisyrinchium* Linnaeus in the
**Family**: Iridaceae A. L de Jussieu (Cronquist, 1981).

Goldblatt (2002) lists sixteen genera within the family Iridaceae in North America. *Sisyrinchium* and its immediate allies are divided into four sections, with *Sisyrinchium* sect. *Sisyrinchium* characterized by compressed stems and globose seeds usually with a large pit (Goldblatt and Rudall, 1990). Nearly all the species of the genus *Sisyrinchium* alliance lack styloid crystals, a basic and specialized feature within the family Iridaceae (Glodblatt et al., 1984; Goldblatt, 1990, cf. Goldblatt, 1990). The following morphological characteristics of the genus *Sisyrinchium* have been excerpted and paraphrased in brief from Cholewa and Henderson (2002): The genus *Sisyrinchium* are annual or perennial herbs, often cespitose, rhizomatous or not, with thickened, fleshy roots. The stems are scapelike or branched, compressed, and two-winged. The leaves are basal and cauline, alternate, basally equitant and usually glabrous. The inflorescence is usually terminal; two equitant spathes that are usually connate basally. The actinomorphic flowers are not fragrant and have widely spreading tepals that are violet to light blue, white, lavender to pink, magenta, purple, or yellow. The stamens are symmetrically arranged, with distinct filaments that are connate basally into a tube. The anthers surround but are not appressed to the style. The capsule is globose, smooth to roughened by underlying seeds that are globose to obconic or hemispherical with a black seed coat that is granular to rugulose. The basic chromosome = 8.

The treatment of North American species within the genus *Sisyrinchium* began in earnest in last two decades of the nineteenth century by Bicknell (1896, 1899) and Greene (Henderson, 1976). Bicknell proposed a plethora of names, many of which have been reduced to conspecific status by Fernald (1950) and Gleason and Cronquist (1963) (Hill, 1984). Bicknell's work was based largely on the examination of herbarium material and he did not take into account the extreme interpopulational variation which can occur n some external characteristics such as branched versus simple stems, perianth color, and tepal length (Hornberger, 1987; Henderson, 1976). Henderson (1976) states that, "Even a superficial examination of local and regional floras available for North America will disclose the inconsistencies in taxonomic treatment of the genus *Sisyrinchium* (Iridaceae)". *Sisyrinchium* is a complex polyploid taxon in which the species are not always easily distinguished. When immature, plants of branched species appear to be simple-stemmed and those of simple stemmed species occasionally are branched. Vegetative characteristics, while distinctive in some species, may overlap greatly in wide ranging species (Cholewa and Henderson, 2002). Henderson (1976) considered much of the confusion regarding *Sisyrinchium* taxonomy to be two-fold. "Unless great care are taken in preservation, the structural characteristics are seldom evident, which not only makes identification of dried material difficult in the absence of detailed field notes, but also obscures natural floral variation. Secondly, intrapopulational variation of several external features is, in some cases, extreme, and unless a large sample is

used as the basis for character evaluation, identification may be difficult, if not impossible. Even the most limited field observations will often disclose a gradation of character expression encompassing in a single population three or more of the taxa of Bicknell and Greene." Ward (1959) pointed out that the width of stem and leaves, which is highly significant during the separation of species, is greatly modified by the process of pressing and drying the plants, and measurements taken from herbarium specimens may be significantly smaller than measurements taken from living plants.

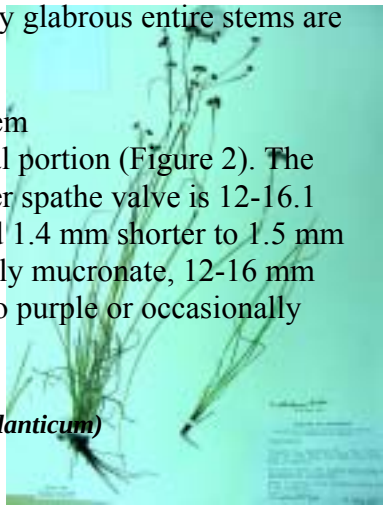
Henderson (1976) and Cholewa and Henderson (1984) worked to resolve the taxonomic confusion regarding the members of this genus in the Pacific Northwestern, Great Basin, and Rocky Mountain regions. Their work included the investigation of the morphology, cytology, flavonoid patterns, genetic compatibility, breeding systems, and geography of the species. Dissertations by Hornberger (1980), Ward (1959) addressed the systematics of species in the southeastern and northeastern United States. Most recently, Cholewa and Henderson (2002) completed the taxonomic treatment on North American *Sisyrinchium* for the Flora of North America project. This treatment recognizes 37 species including *S. atlanticum.*

Bicknell described *S. atlanticum* in 1996, from specimens collected at Van Cortlandt Park in New York City. The work of Bicknell and others resulted in the describing of numerous species and varieties that later were determined to be good *S. atlanticum*. These names include, *S. apiculatum*; *S. apiculatum* var. *mesochorum* Nieuwland; *S. corymbosum* E. P. Bicknell, *S. flexile* E. Bicknell; *S. mucronatum* Michaux var. *atlanticum* (E. Bicknell) H. E. Ahles; *S. scoparium* E. Bicknell, *S. tracyi* E. P. Bicknell, *S. violaceum* E. Bicknell (Cholewa and Henderson, 2002). The chromosome number of this species has been reported as n = 8, 16, and 48 (Hornberger, 1987). Love and Love (1958 cf. Hornberger, 1987) reported 2n = 96 for this species in southern Maine. Hornberger's comparison of *S. atlanticum* from northern and southern latitudes concluded that there were no appreciable morphological differences. Her work agreed with earlier work by Mosquin (1970, cf. Hornberger, 1987), that apparent differences in chromosome number are not associated with morphological differentiation.

## DESCRIPTION OF SPECIES


**Figure 2**: *S. atlanticum* stem

The following species description is based largely on information provided by Cholewa and Henderson (2002), Voss (1972), and Hornberger (1987). *S. atlanticum* is a cespitose perennial herb that ranges to 5.7 dm in height, with dark fibrous roots (Figure 1). The plant dries pale green to straw colored. The leaf blades are glabrous with the occasionally becoming fibrous, but not persistent in tufts. The usually glabrous entire stems are branched with one or two nodes and are 0.8-1.9 mm wide. The stem wings are 0.2-0.6 mm wide and distinctly narrower that the central portion (Figure 2). The spathes are green with occasional purple on the margins. The outer spathe valve is 12-16.1 mm long, 1.8-2.6 mm wide, connate at the base for 3-5.2 mm, and 1.4 mm shorter to 1.5 mm longer than the inner spathe (Figure 3). The inner valve is distinctly mucronate, 12-16 mm long, 1.3-2.1 mm wide. The tepals are light blue or bluish violet to purple or occasionally



white, bases yellow. The outer tepals are 6.3-11 mm long with an emarginate to truncate aristate apex. The filaments are ± connate entirely, stipitate glandular basally with blackish ovary. The capsules are dark brown to black or purplish black, small, dark brown, black, or purplish-black ± globose to obovoid, 2-4.1 mm long. The pedicel is ascending or erect. The seeds are globose to obconic, lacking obvious depression, 0.5-1.2 mm, rugulose or occasionally glandular.


**Figure 1**: *S. atlanticum* habitat

## LIFE HISTORY

Little is known about the life history *S. atlanticum*, though inference can be drawn from work that has been done with other species by Henderson (1976) and Cholewa and Henderson (1984). *S. atlanticum* is a cespitose perennial that typically has branched stems.

**Figure 3**: *S. atlanticum* spathe

Cholewa and Henderson (1984) indicate that

growth and development of perennating buds, located near the base of the plant, is the common method of vegetative propagation in the genus *Sisyrinchium*. The authors observed vivipary, fertile plants from the axil of the two-spathe bracts, in six common gardens and greenhouse-cultivated plants under 16-hr days. Allard and Garner (1940, cf. Cholewa and Henderson, 1984) reported vivipary (in an eastern species) under short (10 hr) days.

Previous studies in the genus (Ingram, 1968; Henderson, 1976 cf. Cholewa 1984) have reported both outcrossing and selfing. Self-sterility, protandry, or the activity of insects apparently promotes outcrossing. A correlation between breeding systems and ploidal levels has also been demonstrated by these same studies; self pollination is reported to be frequent in some duodecaploids, whereas some tetraploid are self-incompatible. Henderson (1976) observed cross-pollination in natural populations in the northwestern species to be accomplished by solitary bees of the family *Megachilidae.* In the Rocky Mountains, some populations of *Sisyrinchium* are pollinated by solitary bees of the genus Lasioglossum Curt (Cholewa and Henderson, 1984. Observations of these populations indicate that bees visit *Sisyrinchium* flowers at an apparently random fashion, in some instances visiting neighboring plants, other times passing several flowering plants before making another visit. Although insect pollination is generally thought to promote outcrossing, observations of solitary bee behavior coupled with the self-incompatibility and self-pollination results indicate that insect pollinators may also effect self-pollination in *Sisyrinchium* (Cholewa and Henderson, 1984). This self-pollination could occur if the stigma maturation and anther dehiscence occur simultaneously and if the syle elongation has brought the stigmas to nearly the same height as the anthers. Self-incompatible plants often have the style well-exerted from the staminal tube versus styles equal in length to the filaments in self compatible plants (Cholewa and Henderson, 1984). Intraspecific crossability (the ability to produce seeds) was high in most Rocky Mountain species studied by Cholewa and Henderson (1984). Interspecific crossability was high in species of the same ploidy level but low in interploidal species.

## HABITAT

Throughout the range *S. atlanticum* prefers moist sandy substrates that are subject to fluctuating groundwater levels. These sites include beaches, lake-edges, ditches, woods, bogs, roadsides, prairies, acid seeps, sinkhole pond margins, and cemeteries. Sites appear to be mildly acidic and are typically in full light. Reznicek (1994) indicates that the majority of coastal plain disjunct species occur on sandy or gravelly shores of shallow, small, soft-water ponds and lakes with fluctuating water levels, or sometimes in low, sandy, periodically flooded swales. In these habitats, coastal plain species appear only during years of low water levels, when extensive areas of suitable habitats are exposed. During high water years, these species survive mostly as seeds in the soil under the water. Where coastal plain disjuncts are frequent and natural stands occur nearby, man-made habitats, such as sandy borrow pits scraped to the water table, cleared wet, sandy fields, or even shallow ditches, may offer suitable habitats.

In Gray's Manual of Botany 8th Edition, Fernald (1950) characterizes *S. atlanticum* habitat as damp to dry meadows, swales, marshes, and low woods. Henderson and Cholewa (2002) describe the habitat as moist meadows and coastal dunes in sandy, peaty, or rich, loamy soil. Swink and Wilhelm (1994) denote that the greatest concentration of *S. atlaticum* in the Chicago Region is in the Kankakee River valley in Indiana where it has been found in a sand barren with species such as, *Aronia prunifolia*, *Comptonia peregrina*, *Helianthus mollis*, *Potentilla simplex*, *Viola lanceolata*, and *Viola sagittata*. In Michigan, Reznicek collected this species on a moist, open, sandy roadside road on a natural gas pipeline corridor (Reznicek 7809 MICH), in a large swale with *Eleocharis melanocarpa and Calamagrostis canadensis* (Reznicek 10138 MICH), and in a shoreline meadow with *Cladium mariscoides*, and *Calamagrostis canadensis* (Reznicek 5225 MICH). Other examples of habitats at collection sites in include, wet sandy barrens and swamp forest in Kentucky (Cranfill 766 MICH), moist swales in oak barrens in Tennessee (Kral 52792 MICH), moist ravine in west slope of loess bluffs in Mississippi (Hardin 481 MICH), wet sand in a grassy roadside ditch in Florida (Brunton 11809 MICH), and a damp pine wood in Georgia (Koelz 13404 MICH).

## DISTRIBUTION AND ABUNDANCE

*S. atlanticum* ranges from Nova Scotia to Florida, west to Mississippi, north to Wisconsin and east to Maine. The frequency of occurrence is greatest along the Atlantic coastal plain, with locally occurring populations in the Great Lakes and Midwest regions. The limited extent of coastal plain habitat type in the interior states serves to explain, in part, the general rarity of the species in these states. Destruction of the already limited amount of available habitat has served to further reduce the number of extant sites.

The species is not actively tracked by state conservation agencies in Indiana, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, West Virginia, and Wisconsin (Table 1). In Illinois, this species historically occurred in six counties but only two populations are currently known (Illinois Plant Information Network, 2002). No data on the population size is available. Although historically occurring in three counties in Ohio, it is currently presumed to be limited to three extant populations in sedge

meadow complexes in Lucas County (McCormac per comm., 2002). Roads and Block (2000) consider *S. atlanticum* a rare component in the flora of Pennsylvania, occurring primarily in the southeastern portion of the state. According to Kunsman (per comm., 2002) there are three extant occurrences in Bucks County in the southeast, these being relegated to previously disturbed sites such as powerline right-of-way and fields in sandy soil. In Michigan, this species is currently known to occur only within coastal plain habitat in two counties bordering Lake Michigan. Post 1980 collections are from four small populations in Allegan and Muskegon Counties. Missouri currently has 18 extant and four historical records in 11 counties for *S. atlanticum* (Smith per comm., 2002). Data was not available on the occurrence records of *S. atlanticum* in Delaware. There is one known and six historic occurrences in Vermont (Turner, 2002). Three collections are post 1960.

**Table 1:** Status of *Sisyrinchium atlanticum* within States comprising Region 9

| State | State Rank | State Status | Comment |
|---|---|---|---|
| CT | - | - | Not tracked; possibly common along coast |
| DE | S3 | - | Rare |
| IL | S1 | E | Rare; documented in six counties |
| IN | - | - | Not tracked; uncommon; historic in 10 counties; NE and SW of state |
| IO | - | - | Not documented |
| ME | - | - | Not tracked; rare; documented in three coastal counties |
| MD | | | Not tracked; status uncertain |
| MA | - | - | Not tracked; native to all counties |
| MI | S2 | T | Documented in two counties |
| MN | - | - | Not documented |
| MO | S2 | | Not tracked: uncommon; 18 extant + 4 historical sites in 11 counties. |
| NH | - | - | Not tracked; occasional, concentrated primarily in southern NH; four counties |
| NJ | - | - | Not tracked |
| NY | - | - | Not tracked; 12 counties, 24+sites |
| OH | S2 | E | Known from three populations, other historic sites probably gone |
| PE | S1 | E | Documented from four counties |
| RI | - | - | Not tracked; current status uncertain but historically infrequent |
| VT | SH | - | One current site, one county; 6 historic sites |
| WV | - | - | Not tracked |
| WI | - | - | Not tracked |

[1] *Sisyrinchium atlanticum* is ranked as G4G5 for all states assigning a rank or status. Plants are considered globally secure. S1=critically imperiled, S2=rare, 6-20 occurrences; S3=uncommon, 21-100 occurrences dependent upon state; S4=apparently secure in state; SC=Special Concern (on watch list); SH=State Historical occurrence; SU=possibly in peril in state but status uncertain; T=State Threatened, possibility of becoming endangered; E=Endangered.

Cholewa has identified vouchers collected in the Chequamegon-Nicolet National Forest (Root 1015 and 1282 UWGB) as *S. atlanticum*, with apparent reservation concerning the location of the populations relative to the species known range. Data on the extent of the populations was not available. A specimen appearing to be *S. atlanticum* has been observed in the Huron-Manistee National Forest (Ruta per comm., 2002), however, a voucher has not been submitted to major herbaria for authentication. Collections made in 1900, 1913, and

1916 in Windham and Bennington counties, Vermont, may have been from Green Mountain-Finger Lakes National Forest; however, their exact location is not certain (Turner 2002). Turner does, however, list one occurrence in the Green Mountain National Forest (Turner, 2002). *S. atlanticum* has been documented as occurring in 30-counties in the Mark Twain National Forest proclamation boundary; however, it is not known to occur in the Forest (Lane per comm., 2002). *S. atlanticum* is not known to occur in any other R9 Forests.

**Table 2**: Status of *Sisyrinchium atlanticum* within National Forests comprising Region 9

| National Forests | Comment |
|---|---|
| Allegheny | Not documented |
| Chequamegon-Nicolet | Documented at two sites in Forest County |
| Chippewa | Not documented |
| Green Mountain-Finger Lakes | Historic collections from 1900, 1913, and 1916 may have been from Forest |
| Hiawatha | Not documented |
| Huron-Manistee | Documented (pending species verification);one site |
| Hoosier | Not documented |
| Midewin | Not documented |
| Mark Twain | Documented from 30 counties in proclamation boundary; not in Forest. |
| Monongahela | Not documented |
| Ottawa | Not documented |
| Shawnee | Not documented |
| Superior | Not documented |
| White | Not documented |
| Wayne | Not documented |

## POPULATION BIOLOGY AND VIABILITY

The population biology of *S. atlanticum* has not been studied to date. In general, the distribution of *S. atlanticum* coincides with the presence of coastal plain habitat or in natural or man-made openings that closely approximate suitable natural habitat. Literature indicate it colonizes roadsides, utility right-of-way, and other openings that typically have a moist sand substrate. The inland areas supporting these disjunct species are all sand deposits associated with post-glacial lakes and drainage channels (Reznicek, 1994). The species density and frequency of occurrence at suitable habitats probably varies relative to the water levels present. Although limited information is available on the extent of the known populations, they appear to generally be relatively small. This species may be intolerant of shade and susceptible to the encroachment of woody and certain herbaceous vegetation.

Based on work with other species (Henderson, 1976; Cholewa and Henderson, 1984) it is doubtful that *S. atlanticum* has developed any unique pollinator/plant relationships. Some species are known to reproduce vegetatively, though information on *S. atlanticum* is lacking. The genus displays considerable intraspecific compatibility. It is not known what, if any, role herbivory plays in population dynamics.

Environmental, demographic, and genetic stochasticity, natural catastrophes and anthropogenic activities all apply pressure to natural populations. Lande (1993, 1998 cf. Soule′ and Orians, 2001) has shown that demographic stochasticity is unlikely to be important for any population that has more than 100 individuals, but random environmental variation or catastrophes are important for populations of all sizes, and they become more significant as environmental variability becomes large in relation to the population growth rate. *Sisyrinchium* is a complex polyploid taxon that displays a great deal of phenotypic plasticity. Phenotypic plasticity may serve to help buffer populations from environmental variation (Menges, 1991 cf. Falk and Holsinger, 1991).

Small populations may be genetically depauperate as a result of changes in gene frequencies, owing to founder effects or inbreeding. If a population suffers form-inbreeding depression, then it short-term viability may be compromised. (Menges1991, cf. Falk and Holsinger 1991). Cholewa (per comm., 2002) indicates that there is a lot of polyploidization in the genus *Sisyrinchium* and believes that this is the biggest factor attributed to the rarity of certain species. She cites *Sisyrinchium dichotomum* as a species that hardly produces viable seed in spite of available pollinators, suggesting genetic imbalances because of hybridization and polyploidization as a potential reason. If *S. atlanticum* is capable of reproducing by vegetative and/or apomictic means, similar to other species in the genus, it may be able to take advantage of environmental disturbance and expand current colonies regardless of limits on genetic diversity. Many rare plants probably maintain considerable amounts of ecologically significant genetic variation. Reduced genetic diversity is unlikely to be a significant threat to the persistence, especially in the relatively short-term relevant for conservation (Falk and Holsinger, 1991).

## POTENTIAL THREATS AND MONITORING NEEDS

Although the global viability of *S. atlanticum* appears secure in the short term, those small isolated inland populations that are disjunct from the main coastal population inland populations will continue to be subject to stochastic events that may threaten their existence. Our lack of knowledge about the biology of the species does not permit an assessment of the minimum viable population required to maintain the species in the long-term. Detailed studies of the breeding system and additional searches for historic and new populations need to be conducted prior to assessing the real threat of demographic or genetic stochasticity. Reznicek (1994) considers conservation of the coastal plain flora in the Great Lakes region an important issue because of the some of the long-isolated disjunct populations may represent unique genotypes.

*S. atlanticum* has been occasionally observed along transportation and utility corridors. Maintenance of these corridors can have both negative and positive effects upon this species. Soil grading or herbiciding could result in the total destruction of the population or degradation of optimal habitat; however, the removal of encroaching woody vegetation or mowing of dense grass and herbs would reduce shade and potential resource competitive plants. The threat from invasive non-native species is or will likely become an issue at some sites harboring this species. Gilman (per comm., 2002) indicates that important management for *Sisyrinchium* is to maintain a thin turf and suppression of thick turf grasses. He believes that fires could be detrimental to the shallow root systems of *Sisyrinchium*. Reznicek (1994)

cites recreational development, off road vehicle traffic, drainage, dredging, elimination of natural water level fluctuations, and eutrophication as principal threats to the coastal plain flora. He suggests that since sites for coastal plain species frequently occupy small areas of shoreline on otherwise more or less developed lakes, control over hydrological alteration, especially stabilization of water level, is especially difficult.

The prioritized strategy developed by Farnsworth and DiGregorio (2002) for purple milkweed (*Asclepias purpurascens*) in New England is potentially applicable to *Sisyrinchium atlanticum*. The authors suggest that the general actions, in descending order of importance, include;
(1) land acquisition or protection of occurrences;
(2) regular surveys of known occurrences;
(3) de nova searches for new populations;
(4) ex-situ activities including seed banking, germination research and propagation;
(5) habitat and site management;
(6) species biology research; and
(7) augmentation, introduction, and reintroduction.

Additional botanical surveys in suitable habitat on public and private lands should be initiated to better assess the status, particularly in those states in which the species is considered a disjunct as well as those Atlantic coastal plain states where populations have been greatly reduced by anthropogenic activities. These surveys should be conducted in suitable habitat more than one growing season to allow for the potential absence of the species during high water levels and during any given low water period. This attention will hopefully result in the discovery of additional populations.

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