# *Scirpus longii*

**Long's Woolgrass**

**Cyperaceae**

*Scirpus longii* by Bryan Connolly, 2020

## *Scirpus longii* Rare Plant Profile

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
State Forest Fire Service & Forestry
Office of Natural Lands Management
New Jersey Natural Heritage Program

501 E. State St.
PO Box 420
Trenton, NJ 08625-0420

Prepared by:
Jill S. Dodds
jsdodds@biostarassociates.com

August, 2022

For:
New Jersey Department of Environmental Protection
Office of Natural Lands Management
New Jersey Natural Heritage Program
natlands@dep.nj.gov

This report should be cited as follows: Dodds, Jill S. 2022. *Scirpus longii* Rare Plant Profile. New Jersey Department of Environmental Protection, State Parks, Forests & Historic Sites, State Forest Fire Service & Forestry, Office of Natural Lands Management, New Jersey Natural Heritage Program, Trenton, NJ. 16 pp.

## Life History

*Scirpus longii* is a rhizomatous perennial graminoid in the Cyperaceae. The sedge spends most of its life in a vegetative state, usually flowering only in response to disturbance (Schuyler 1962). The lengthy rhizomes of *S. longii* cause the plants to grow in an outward-expanding fashion so that it develops large, circular colonies (Hill and Johansson 1992, Arsenault et al. 2013). The age of plants can be estimated by annual bulges along the underground stems (Hill 1993) and the clones are long-lived: Some are thought to be hundreds of years old (COSEWIC 2017). The clonal growth allows *S. longii* to become dominant at some sites (Enser and Caljouw 1989) and in Nova Scotia it has been described as forming "vast, almost pure meadows of thousands of ramets" (Wisheu et al. 1994). In some places stand size has been measured in acres (Russell et al. 2019).

Left: Scan of dried plant, courtesy of Harvard University Herbaria. *Right*: Vegetative growth by Colin Chapman-Lam, 2019.

In flower and fruit, *Scirpus longii* resembles the more common and widespread woolgrass (*Scirpus cyperinus*). The culms are tall (9–14 dm) and upright with 4–7 rough-edged leaves that are 30–54 cm long and 3–9 mm wide. The branching inflorescence contains hundreds of spikelets on long spreading or drooping pedicels and the achenes have six long, pale bristles that extend beyond the subtending scales and give the spikelets a wooly appearance. There are several reliable ways to distinguish *S. longii* from similar species: The bracts below each flower cluster are black and sticky at the base, the spikelet scales are 2–3 mm long, and the achenes are a dark reddish-brown color. *S. longii* plants are likely to flower during the early part of the summer in contrast with *S. cyperinus* which usually blooms later in the season, and other similar species have shorter, narrower rhizomes and grow in tufts or tussocks rather than spreading colonies. (See Fernald 1911, Beetle 1943, Fernald 1950, Schuyler 1963, Schuyler 1967, Gleason and Cronquist 1991, Arsenault et al. 2013, Weakley 2015, Whittemore and Schuyler 2020). *Scirpus longii* is able to hybridize with *S. cyperinus*, forming plants that are capable of sexual

reproduction, but the occurrence of hybrids is rare due to the asynchronous blooming times of the two species and the infrequent flowering in *S. longii* (MacKay et al. 2010, MacKay 2011).

## Pollinator Dynamics

When *Scirpus longii* does flower, it can begin as early as May in New Jersey (Hough 1983). The majority of species in the Cyperaceae are pollinated by wind and, while there are a few notable exceptions in scattered genera, no alternative pollination mechanisms have been reported for *Scirpus* (Goetghebeur 1998). Wind pollination is generally considered to be the mechanism utilized by *S. longii* (Rawinski 2001, Farnsworth and Ogurcak 2008).

In nearly all sedges the female flowers develop before the male flowers, which is thought to be a way of enhancing the opportunity for cross-fertilization (Goetghebeur 1998). However, Rawinski (2001) suggested that self-compatibility was likely in *S. longii*. A range-wide analysis of Long's Woolgrass showed that genetic diversity in the species was extremely low (Spalink et al. 2019).

## Seed Dispersal

Fruit development in *Scirpus longii* usually takes place early in the summer (Whittemore and Schuyler 2020) and Stone (1911) observed that the achenes matured between mid-June and mid-July, dropping from the plants with their scales attached. However, fruiting occasionally takes place later in the season and New Jersey plants may flower as late as August (Hough 1983, Russell et al. 2019). A single culm can produce thousands of small (0.7–1 × 0.4–0.5 mm) achenes with long, contorted bristles (Whittemore and Schuyler 2020). The cottony bristles enhance transportation by wind (Hill 1993, Goetghebeur 1998) but they can also facilitate attachment to floating vegetation or animals (Leck and Schütz 2005), creating multiple pathways for the dispersal of propagules. Gravity, water movement, and consumption by waterfowl have also been reported as dispersal mechanisms for *Scirpus* achenes (Leck and Schütz 2005). Seed dispersal in *S. longii* can take place slowly over a period of several months, sometimes continuing into the winter (COSEWIC 2017).

Propagation experiments showed that 34% of *Scirpus longii* seeds germinated rapidly when fresh but germination was poor following a three-month period of cold treatment (Brumback 1989). Schuyler and Stasz (1985) observed that a fire triggered a high rate of flowering in burned stands of *S. longii* and seedlings established during the same year that the plants had bloomed. Fire may trigger flowering because it creates suitable sites for seed germination, a process which is enhanced by light in *S. longii* (Schuyler 1962, Schuyler and Stasz 1985). However, culm formation can also be triggered by other types of disturbance including flooding and muskrat herbivory (Rawinski 2001, COSEWIC 2017). The fact that *S. longii* seeds are viable upon dispersal does not rule out the possibility that some seeds may also remain in the soil, particularly when conditions are less favorable for germination. The behavior of Long's Woolgrass at some New Jersey sites has been suggestive of seed banking (Snyder 1993) and long-term dormancy has been documented in other *Scirpus* species (Leck and Schütz 2005).

After the seeds germinate *S. longii* seedlings can sometimes develop quickly enough to flower within six months, but more often the young plants take 6–10 years to reach maturity (COSEWIC 2017). Although many plants in the genus *Scirpus* form mycorrhizae (Wang and Qiu 2006) that is not thought to occur in *S. longii* (Farnsworth and Ogurcak 2008).

Potential mechanisms for vegetative dispersal have also been identified for *Scirpus longii*. At some locations rhizomes become fragmented by muskrats or ice scour and pieces can be transported to new locations by water movement (COSEWIC 2017). Bulblets can occasionally develop in the axils of inflorescences, although that is rare in the species (Whittemore and Schuyler 2020).

## Habitat

*Scirpus longii* is most often found at open sites on peaty soils at elevations of 0–200 meters (Russell et al. 2019, Whittemore and Schuyler 2020). Although the sedge is nearly always associated with oligotrophic environments (Rawinski 2001) it has been reported growing in more mesotrophic conditions in Massachusetts (Reid 2000). Typical natural habitats cited for *S. longii* include acidic fens, carrs, marshes, seasonal ponds and pond margins, savannas and river oxbows, swales, and wet meadows (Arsenault et al. 2013, Fairbrothers and Hough 1973, Calazza and Fairbrothers 1980, Schuyler and Stasz 1985, Rawinski 2001, Johnson and Walz 2013, NJNHP 2022). In New Jersey, Long's Woolgrass is frequently associated with Pitch Pine (*Pinus rigida*) lowlands (Johnson and Walz 2013, NJNHP 2022). Enser and Caljouw (1989) remarked on the similarity between the species' acidic fen habitat in Rhode Island and the peatland communities of the New Jersey Pine Barrens. Some Maine habitats have been described as lakeshore fen (MENAP 2021), and in southwestern Nova Scotia where *S. longii* reaches its northernmost extent the species has also been found on the margins of lake outlets and in bay or barrier bogs. Bay bogs are filled-in areas in which develop in the sheltered bays of lakes, and barrier bogs are separated from an adjacent lake or river by a rocky barrier (Hill and Johansson 1992). *Scirpus longii* has also been documented in an assortment of man-made habitats including railway cuts, utility right-of-ways, cranberry bogs, and excavated ponds (Schuyler 1962, Rawinski 2001, Johnson and Walz 2013, NJNHP 2022).

*Scirpus longii* can be seen both in and out of standing water (Calazza and Fairbrothers 1980) but the majority of its habitats are characterized by fluctuating water levels (Schuyler and Stasz 1985, Hill and Johansson 1992, Rawinski 2001, Johnson and Walz 2013). Periodic flooding in coastal plain communities helps to keep shrub succession in check (Keddy and Wisheu 1989), and when the substrates in *S. longii* habitats dry out the sites are prone to fires which both eliminate shrubs and promote sexual reproduction in the sedge. In Nova Scotia's bay bogs, *S. longii* is confined to the wetter central portions of the communities where shrub growth is naturally depressed (Hill and Johansson 1992). Sweeney and Oglivie (1993) suggested that the distribution of *Scirpus longii* is determined by seasonal variation in water levels, and Farnsworth and Ogurcak (2008) characterized the sedge as a disturbance-dependent species.

## Wetland Indicator Status

*Scirpus longii* is an obligate wetland species, meaning that it almost always occurs in wetlands (U. S. Army Corps of Engineers 2020).

## USDA Plants Code (USDA, NRCS 2022)

SCLO

## Coefficient of Conservatism (Walz et al. 2018)

CoC = 9. Criteria for a value of 9 to 10: Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance (Faber-Langendoen 2018).

## Distribution and Range

The worldwide range of *Scirpus longii* is limited to the north Atlantic region of the United States and Canada (POWO 2022). The map in Figure 1 depicts the global extent of Long's Woolgrass. All known occurrences are within 70 kilometers of the coast (COSEWIC 2017).

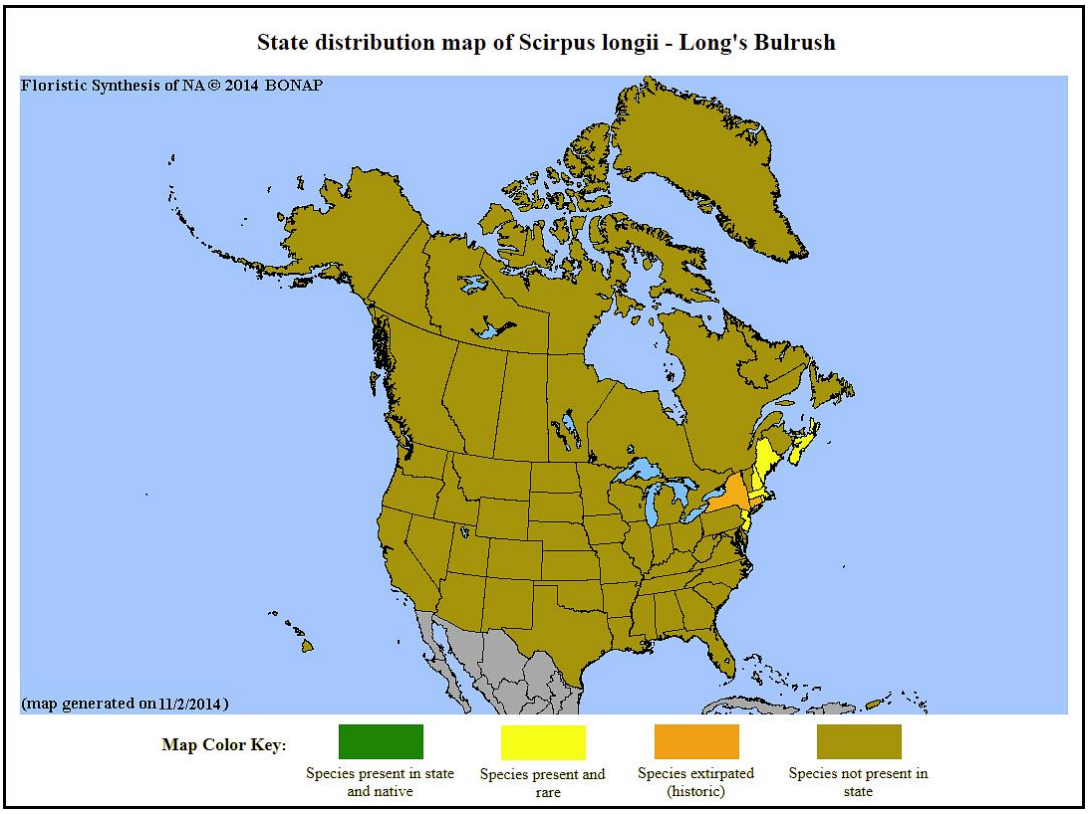


*Figure 1. Distribution of S. longii in North America, adapted from BONAP (Kartesz 2015).*

The USDA PLANTS Database (2022) shows records of *S. longii* in six New Jersey counties: Atlantic, Burlington, Camden, Cape May, Mercer, and Ocean (Figure 2). A record is also reported from Gloucester County (Mid-Atlantic Herbaria 2022). The data include historic observations and do not reflect the current distribution of the species.

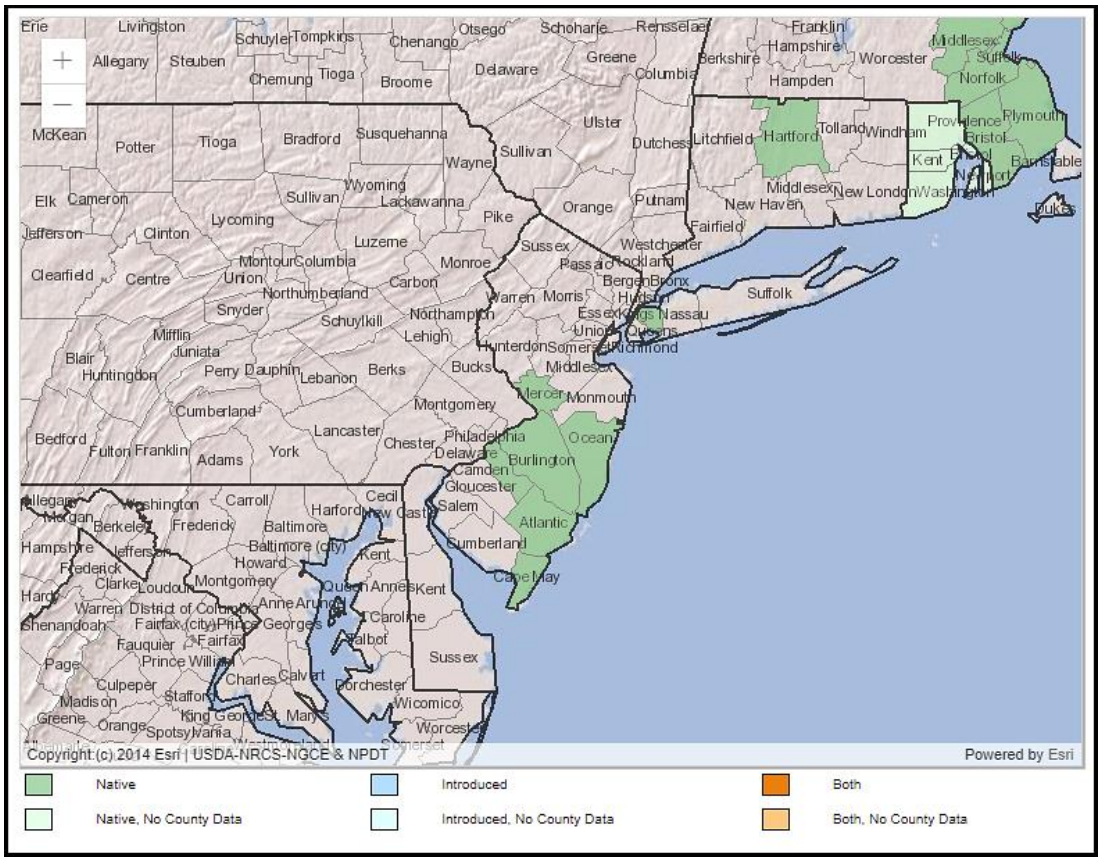


*Figure 2. County records of S. longii in New Jersey and vicinity (USDA NRCS 2022).*

## Conservation Status

*Scirpus longii* is globally vulnerable. The G3 rank means the species has a moderate risk of extinction or collapse due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors (NatureServe 2022). The map below (Figure 3) illustrates the conservation status of *S. longii* throughout its range. The woolgrass is critically imperiled (very high risk of extinction) in New Hampshire and Rhode Island, imperiled (high risk of extinction) in Massachusetts, Maine, and New Jersey, and vulnerable (moderate risk of extinction) in Nova Scotia. Long's Woolgrass is possibly extirpated in Connecticut and likely extirpated in New York. The species is not considered secure anywhere in its range. Historic reports of *S. longii* from North Carolina (e.g. Fernald 1943) turned out to be erroneous (Schuyler 1962).

In North America, *Scirpus longii* has been identified as a plant species of highest conservation priority for the North Atlantic region, which includes four Canadian provinces and twelve U. S.

states. The species has a regional rank of R3 (vulnerable), signifying a moderate risk of extinction (Frances 2017). Despite its rarity in the United States, *S. longii* is not presently listed at the federal level (USFWS 2011). Long's Woolgrass has been classified as a Category 2 species, indicating that listing may be appropriate but insufficient information is available regarding its biological vulnerability (USFWS 1993). In Canada, *Scirpus longii* has been classified as a species of special concern (COSEWIC 2017).

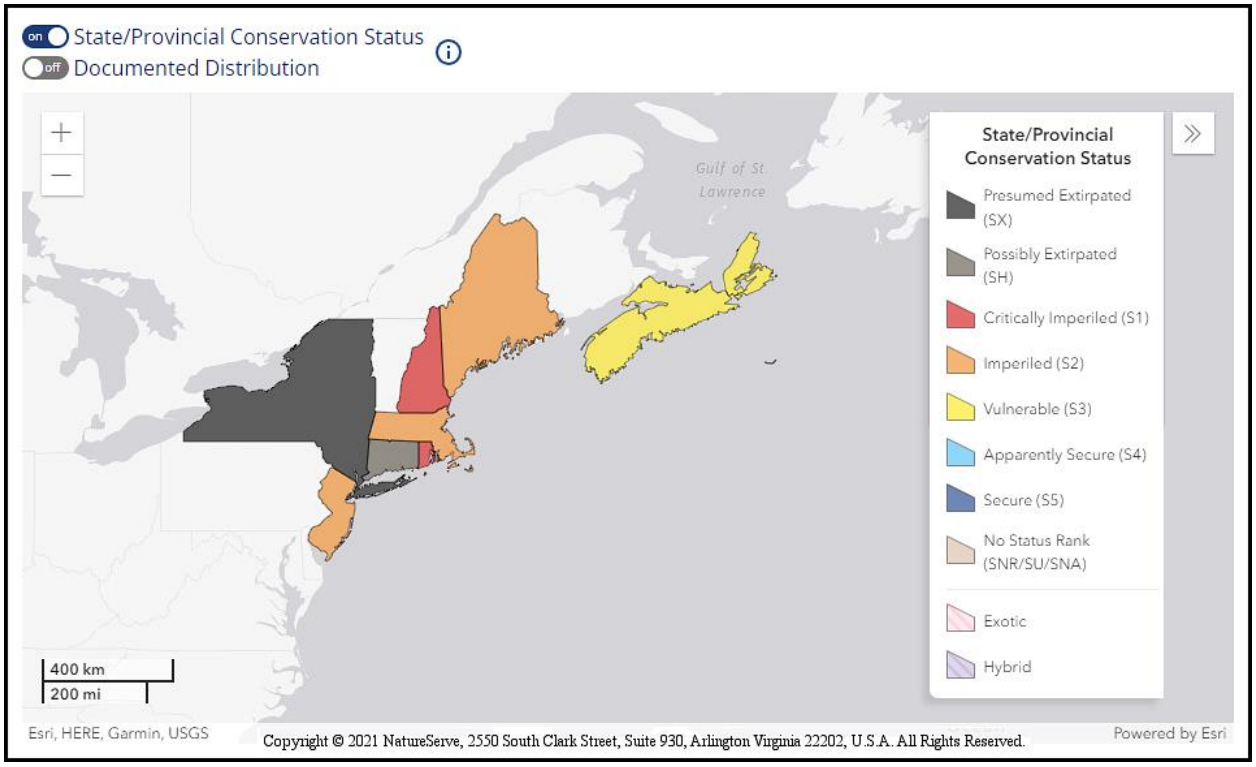


*Figure 3. Conservation status of S. longii in North America (NatureServe 2022).*

*Scirpus longii*'s imperiled (S2) status in New Jersey indicates that the species is very rare in the state, with 6 to 20 occurrences (NJNHP 2022). Species with an S2 rank may have once been more abundant but now persist in only a few of their former locations. *S. longii* is also listed as an endangered species (E) in New Jersey, meaning that without intervention it has a high likelihood of extinction in the state. Although the presence of endangered flora may restrict development in certain communities such as wetlands or coastal habitats, being listed does not currently provide broad statewide protection for the plants. Additional regional status codes assigned to the sedge signify that the species is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010).

*Scirpus longii* was collected in Massachusetts by Henry David Thoreau during the 1850s, but Thoreau was unable to identify the species because it had not yet been described (Fernald 1913). In 1909 the sedge was found in New Jersey by Witmer Stone, who recognized it as a new species and named it for his colleague Bayard Long (Stone 1911). After receiving some specimens from Stone, Merritt Fernald published the initial description (Fernald 1911)—thereby including the bulrush in a group of two dozen plant species first described from material originating in the New Jersey's Pine Barrens (Fairbrothers 1979). Numerous collections were made in southern

New Jersey in the years that followed the initial discovery (NJNHP 2022), but by the middle of the century Fables (1956) reported that the species was not known to be present anywhere in the state. Vincent Abraitys relocated *S. longii* during the late 1960s (Snyder 1984) and the species is currently extant at 14 locations, including one rediscovered by Abraitys at which the plant was first collected a century ago. Nineteen other occurrences are considered historical in the state (NJNHP 2022).

## Threats

Habitat loss is a past and present threat to *Scirpus longii*. In the past, many intermittent wetlands in southern New Jersey were lost or altered by activities such as peat removal, sand and gravel mining, bog iron mining, cedar logging, and cranberry farming (Johnson and Walz 2013). Development was cited as the cause of loss for a number of populations in Massachusetts and the probable reason that a Connecticut occurrence was extirpated (Crow 1982). Habitat destruction continues to imperil *S. longii*, with peat mining and flooding for the development of hydroelectric power identified as particular concerns in Canada (Rawinski 2001, COSEWIC 2017). On a more local scale the illegal use of all-terrain vehicles—which results in plant destruction and substrate compaction—has often been identified as a threat in the sensitive communities that *S. longii* inhabits (Keddy and Wisheu 1989, Hill 1993, Johnson and Walz 2013, COSEWIC 2017, Russell et al. 2019).

Even when wetlands are protected, agricultural practices and development in adjacent upland areas can reduce water quality and alter community dynamics in *S. longii* habitat (Johnson and Walz 2013, Russell et al. 2019). Nutrient enrichment is a particular threat both specifically to *S. longii* and to coastal plain wetland plants in general because it favors a different suite of species than those that naturally inhabit the sites (Keddy and Wisheu 1989, Rawinski 2001). For example, Spalink et al. (2019) observed that *Typha latifolia* became dominant in a eutrophic wetland to the detriment of *S. longii*. Such changes can also make plant communities more susceptible to colonization by non-indigenous species. A number of invasive plants have been identified as threats to *S. longii* occurrences, particularly *Phragmites australis* ssp. *australis*, *Lythrum salicaria*, and *Frangula alnus* (Rawinski 2001, COSEWIC 2017, Russell et al. 2019). *Phragmites* currently threatens one of New Jersey's *S. longii* populations (NJNHP 2022).

Changes to the natural hydrologic and/or fire regimes that maintain open habitat are recognized threats to savannas and coastal plain ponds in New Jersey (Johnson and Walz 2013) and to intermittent wetlands throughout the range of *Scirpus longii* (Keddy and Wisheu 1989, Rawinski 2001, Russell et al. 2019). One former population of Long's Woolgrass was lost after the establishment of a railroad grade that acted as a dam, permanently flooding the site (Schuyler and Gordon 2002). In many cases, a change in the natural cycle of flooding and drawdown and/or the suppression of fires favors the growth of shrubs, which then become dominant at the expense of *S. longii* and other rare plants that require an open habitat. Succession has been noted as a threat to one extant occurrence in New Jersey (NJNHP 2022). There is some evidence that disturbances do not need to be frequent to maintain *S. longii* populations. The circular, outward growth pattern of Long's Woolgrass gives the species a competitive edge for a number of years, as nutrients become depleted in the center of the clone and the dense outer perimeter forms a

barrier. Hill and Johansson (1992) found that shrub growth was notably lower in the interior of *S. longii* clones. Eventually, however, the effect becomes diminished and the sedge will benefit from a fire that triggers flowering and seedling establishment.

Certain types of disturbance may be either harmful or beneficial to *Scirpus longii* depending on the context. Muskrat herbivory on stems can stimulate the growth of dormant buds and production of flowers (Sweeney and Ogilvie 1993), and muskrats can also create rhizome fragments that result in vegetative dispersal of the sedge (COSEWIC 2017). On the other hand, excessive herbivory by muskrats can decimate a population, particularly one that is already stressed by other factors (Morris et al. 2002). Lakeside populations of *S. longii* can be subjected to ice scour, which may alternately kill or be tolerated by mature plants and can sometimes facilitate vegetative dispersal via rhizome fragments (Hill 1993, Sweeney and Ogilvie 1993, COSEWIC 2017).

Other potential hazards raised as concerns for *Scirpus longii* include seed predation by an insect (Rawinski 2001) and genetic loss due to hybridization (COSEWIC 2017, Russell et al. 2019). The extent of both threats have not been determined. Another unknown is the effect that climate change will have on the species. An assessment of potential climate change impacts on selected New Jersey plants by Ring et al. (2013) ranked *S. longii* as Presumed Stable because the authors found little evidence that its abundance or range would substantially change by 2050. However, their analysis cautioned that the species' risk would increase if its hydrological niche was impacted and that the sedge's potential exposure was enhanced because it reaches the edge of its range in the state. Modeling by Spalink et al. (2019) has projected that nearly half of the extant *S. longii* populations will be exposed to unsuitable climate within the next 50 years. Because New Jersey is situated at the southern end of *Scirpus longii*'s range, occurrences in the state will be on the front line of climate change impacts. New Jersey populations of Long's Woolgrass are therefore particularly well-suited for research concerning the species' adaptability to rapid changes in climactic conditions (Ferren et al. 2013). Stability of extant habitats and a capacity to reach and colonize new sites are likely to be critical to the long-term success of *S. longii* (Spalink et al. 2019).

## Management Summary and Recommendations

Because *Scirpus longii* is imperiled throughout its range it is particularly important to protect extant populations of the species. In addition to preserving the sites supporting the occurrences, consideration must be given to activities in the surrounding landscape in order to maintain the natural hydrologic patterns and water quality of the target wetlands.

Regular monitoring of extant occurrences is necessary to assess the need for active management. Timely action should be taken when the presence of an invasive plant species is detected to prevent its spread. Monitoring visits can serve as an opportunity to document additional observations regarding the conditions that trigger culm formation or the rate at which succession is advancing at particular sites. Routine monitoring can also provide baseline data prior to naturally occurring fires in order to evaluate the sedge's response to an unplanned burn.

*Scirpus longii* is a species for which fire appears to be an appropriate means of management, but additional information would be useful in order to understand the most effective way to utilize that tool. While it seems quite clear that fire stimulates sexual reproduction in Long's Woolgrass, Schuyler and Stasz (1985) raised some important questions about how the process works that remain unanswered. (e.g. Is seedling establishment enhanced by changes in soil chemistry? Increased light? Elimination of competitors? A combination? Something else?) It is also important to determine the fire intensity and timing that are most beneficial to *S. longii*, and to have a better sense of how long the species can persist vegetatively between disturbance periods.

Other aspects of the life history of *S. longii* are also ripe for research. The question of whether the species is able to form and maintain a seed bank is an important one. Studies could investigate other factors that trigger culm formation and determine if they are as effective as fire in fostering seedling establishment. Understanding the significance of competition with other plant species during various life stages would also be useful. Some work has been done regarding ex situ conservation, which may be necessary if the species does not prove resilient in the face of climate change. Seed collected from natural populations of *Scirpus longii* has been preserved in a long-term storage facility (Rawinski 2001), and germination tests have been conducted to evaluate the viability of stored seeds (Russell et al. 2019).

The prospects of relocating historical occurrences or finding new populations of *Scirpus longii* appear to be good. The plants are easily overlooked when they are not flowering. *S. longii* was not discovered in Canada until 1941 (Weatherby 1942), but once botanists began to recognize the sedge in its vegetative state additional occurrences were found (Hill and Johansson 1992). New Jersey has 19 populations that have been ranked as historical, many of which are known only from collections that go back about a century. While specific details regarding the location of those occurrences are likely to be lacking, searches of suitable habitat in the general vicinity by people who can recognize nonflowering *S. longii* plants could be productive.

## Synonyms

The accepted botanical name of the species is *Scirpus longii* Fernald. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA NRCS 2022, POWO 2022).

| Botanical Synonyms | Common Names |
|---|---|
| | Long's Woolgrass |
| | Long's Bulrush |
| | Long's Woolsedge |

## References


Arsenault Matt, Glen H. Mittelhauser, Don Cameron, Alison C. Dibble, Arthur Haines, Sally C. Rooney, and Jill E. Weber. 2013. Sedges of Maine: A Field Guide to Cyperaceae. University of Maine Press, Orono, ME. 712 pp.

Beetle, Alan A. 1943. A key to the North American species of the genus *Scirpus* based on achene characters. The American Midland Naturalist 29(2): 533–538.

Brumback, William E. 1989. Notes on propagation of rare New England species. Rhodora 91(865): 154–162.

Calazza, Nicholas and David E. Fairbrothers. 1980. Threatened and endangered vascular plant species of the New Jersey Pinelands and their habitats. Report prepared for the New Jersey Pinelands Commission. Available at https://rucore.libraries.rutgers.edu/rutgers-lib/37776/PDF/1/play/

Chapman-Lam, Colin. 2019. Photo of *Scirpus longii* from Nova Scotia. Shared via iNaturalist at https://www.inaturalist.org/observations/31844627, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Connolly, Bryan. 2020. Photo of *Scirpus longii* from Massachusetts. Shared via iNaturalist at https://www.inaturalist.org/observations/104575414, licensed by https://creativecommons.org/licenses/by-nc/4.0/

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2017. COSEWIC assessment and status report on the Long's Bulrush *Scirpus longii* in Canada. Ottawa. xiv + 61 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr_Long%27s%20Bulrush_2017_e.pdf

Crow, Garrett E. 1982. New England's Rare, Threatened, and Endangered Plants. U. S. Department of the Interior, Fish and Wildlife Service. 129 pp.

Enser, Richard W. and Caren A. Caljouw. 1989. Plant conservation concerns in Rhode Island—A reappraisal. Rhodora 91(865): 121–130.

Faber-Langendoen, D. 2018. Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments. NatureServe, Arlington, VA. 52 pp.

Fables, David Jr. 1956. Caesarian flora and fauna, Number 1. Published posthumously in Bartonia 31(1960–61): 3–11.

Fairbrothers, David E. 1979. Endangered, threatened, and rare vascular plants of the Pine Barrens and their biogeography. In Richard T. T. Forman (ed.). Pine Barrens Ecosystem and Landscape. Rutgers University Press, New Brunswick, NJ. 601 pp.

Fairbrothers, David E. and Mary Y. Hough. 1973. Rare or Endangered Vascular Plants of New Jersey. Science Notes No. 14, New Jersey State Museum, Trenton, NJ. 53 pp.

Farnsworth, Elizabeth J. and Danielle E. Ogurcak. 2008. Functional groups of rare plants differ in levels of imperilment. American Journal of Botany 95(8): 943–953.

Fernald, M. L. 1911. A new species of *Scirpus* from Massachusetts and New Jersey. Rhodora 13(145): 4–8.

Fernald, M. L. 1913. A new station for *Scirpus longii*. Rhodora 15: 202.

Fernald, M. L. 1943. *Scirpus longii* in North Carolina. Rhodora 45: 55–56.

Fernald, M. L. 1950. Gray's Manual of Botany. Dioscorides Press, Portland, OR. 1632 pp.

Ferren, Wayne R. Jr., G. Russell Juelg, and William Olson. 2013. Rare plants of the New Jersey Pine Barrens: New insights into a unique botanical heritage. New Jersey Flora Project, Chrysler Herbarium, Rutgers University, New Brunswick, NJ. 16 pp.

Frances, Anne (Principal Investigator). 2017. Prioritization and Conservation Status of Rare Plants in the North Atlantic - Final Report. Report prepared for NatureServe by the North Atlantic Landscape Conservation Cooperative, Hadley, MA. Available at https://www.natureserve.org/publications/prioritization-and-conservation-status-rare-plants-north-atlantic-final-report

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Second Edition. The New York Botanical Garden, Bronx, NY. 910 pp.

Goetghebeur, P. 1998. Cyperaceae. In Klaus Kubitzki and T. Stuzel (eds). The Families and Genera of Vascular Plants, Volume 4: Flowering Plants, Monocotyledons: Alismatanae and Commelinanae (Except Gramineae). Springer-Verlag, Berlin. 521 pp.

Harvard University Herbaria. Image of *Scirpus longii* specimen collected in Connecticut, June 18, 1915 (specific location information removed). Licensed by https://creativecommons.org/licenses/by-nc/3.0/

Hill, Nicholas M. and Mats E. Johansson. 1992. Geographical distribution and ecology of Long's Bulrush, *Scirpus longii* (Cyperaceae) in Canada. Rhodora 94(878): 141–155.

Hill, Nicholas. 1993. Two lessons in disturbance. Federation of Nova Scotia Naturalists News 2(4): 9–12.

Hough, Mary Y. 1983. New Jersey Wild Plants. Harmony Press, Harmony, NJ. 414 pp.

ITIS (Integrated Taxonomic Information System). Accessed November 13, 2021 at http://www.itis.gov

Johnson, Elizabeth A. and Kathleen Strakosch Walz. 2013. Integrated Management Guidelines for Four Habitats and Associated State Endangered Plants and Wildlife Species of Greatest Conservation Need in the Skylands and Pinelands Landscape Conservation Zones of the New Jersey State Wildlife Action Plan. Report prepared for NatureServe #DDCF-0F-001a, Arlington, VA. 140 pp.

Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (http://www.bonap.net/tdc). Chapel Hill, NC. [Maps generated from Kartesz, J. T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].

Keddy, P.A. and I.C. Wisheu. 1989. Ecology, biogeography, and conservation of coastal plain plants: some general principles from the study of Nova Scotian wetlands. Rhodora 91(865): 72–94.

Leck, M. A. and W. Schütz. 2005. Regeneration of Cyperaceae, with particular reference to seed ecology and seed banks. Perspectives in Plant Ecology, Evolution and Systematics 7: 95–133.

MacKay, Ron, Sarah Reid, Robert William, and Nicholas M. Hill. 2010. Genetic evidence of introgressive invasion of the globally imperiled *Scirpus longii* by the weedy *Scirpus cyperinus* (Cyperaceae) in Nova Scotia. Rhodora 112(949): 34–57.

MacKay, Ron. 2011. Report: Genetic integrity of Long's Bulrush at Lac de l'École on the Tusket River. Nova Scotia Species at Risk Conservation Fund project number NSSARCF09_05. 17 pp.

MENAP (Maine Natural Areas Program). 2021. *Scirpus longii* Fern, Long's Bulrush. Profile accessed August 10, 2022 at https://www.maine.gov/dacf/mnap/features/scilon.htm

Mid-Atlantic Herbaria. 2022. https://midatlanticherbaria.org/portal/index.php Accessed on August 7, 2022.

Morris, Paul A., Nicholas M. Hill, Edward G. Reekie, and Heather L. Hewlin. 2002. Lakeshore diversity and rarity relationships along interacting disturbance gradients: Catchment area, wave action and depth. Biological Conservation 106: 79–90.

NatureServe. 2022. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed August 7, 2022 at https://explorer.natureserve.org/

NJNHP (New Jersey Natural Heritage Program). 2010. Special Plants of NJ - Appendix I - Categories & Definitions. Site updated March 22, 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2022. Biotics 5 Database. NatureServe, Arlington, VA. Accessed February 1, 2022.

POWO. 2022. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Retrieved August 7, 2022 from http://www.plantsoftheworldonline.org/

Rawinski, Thomas J. 2001. *Scirpus longii* Fern., Long's bulrush. Conservation and Research Plan prepared for the New England Wild Flower Society, Framingham, MA. Available at http://www.newfs.org

Reid, Brian. 2000. *Ludwigia sphaerocarpa* Ell., Globe-fruited False-loosestrife. New England Plant Conservation Program Conservation and Research Plan, prepared for the New England Wild Flower Society, Framingham, MA. 21 pp.

Ring, Richard M., Elizabeth A. Spencer, and Kathleen Strakosch Walz. 2013. Vulnerability of 70 Plant Species of Greatest Conservation Need to Climate Change in New Jersey. New York Natural Heritage Program, Albany, NY and New Jersey Natural Heritage Program, Department of Environmental Protection, Office of Natural Lands Management, Trenton, NJ, for NatureServe #DDCF-0F-001a, Arlington, VA. 38 pp.

Russell, C., D. Snyder, M. D. Cullina, and A. Treher. 2019. *Scirpus longii* conservation status factors. NatureServe, Arlington, VA. Accessed August 7, 2022 at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.142877/Scirpus_longii

Schuyler, Alfred E. 1962. Sporadic culm formation in *Scirpus longii*. Bartonia 32: 1–5.

Schuyler, Alfred E. 1963. A biosystematic study of the *Scirpus cyperinus* complex. Proceedings of the Academy of Natural Sciences of Philadelphia 115: 283–311.

Schuyler, A. E. 1967. A taxonomic revision of North American leafy species of *Scirpus*. Proceedings of the Academy of Natural Sciences of Philadelphia 119: 295–323.

Schuyler, Alfred E. and James L. Stasz. 1985. Influence of fire on reproduction of *Scirpus longii*. Bartonia 51: 105–107.

Schuyler, Alfred E. and Ted Gordon. 2002. Rare plants in the Middle Branch of the Forked River watershed, Lacey Township, Ocean County, New Jersey. Bartonia 61: 117–121.

Snyder, David B. 1984. Botanical Discoveries of Vincent Abraitys. Bartonia 50: 54–56.

Snyder, David B. 1993. Extinct, extant, extirpated or historical? Or in defense of historical species. Bartonia 57 Supplement: 50–57.

Spalink, Daniel, Ron MacKay, and Kenneth J. Sytsma. 2019. Phylogeography, population genetics and distribution modeling reveal vulnerability of *Scirpus longii* (Cyperaceae) and the Atlantic Coastal Plain Flora to climate change. Molecular Ecology 28: 2046–2061.

Stone, Whitmer. 1911. The Plants of Southern New Jersey. Quarterman Publications, Boston, MA. 828 pp.

Sweeney, Sandra and Robert Ogilvie. 1993. The conservation of coastal plain flora in Nova Scotia. Maine Naturalist 1(3): 131–144.

U. S. Army Corps of Engineers. 2020. National Wetland Plant List, version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html U. S. Army Corps of Engineers Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2022. PLANTS profile for *Scirpus longii* (Long's Bulrush). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed August 7, 2022 at http://plants.usda.gov

USFWS (U. S. Fish and Wildlife Service). 1993. Endangered and threatened wildlife and plants: Review of plant taxa for listing as endangered or threatened species. Federal Register 58(188): 51144–51190.

USFWS (U. S. Fish and Wildlife Service). 2011. *Scirpus longii* entry on ECOS (Environmental Conservation Online System). Accessed at https://ecos.fws.gov/ecp/species/4453 on August 7, 2022.

Walz, Kathleen S., Linda Kelly, Karl Anderson and Jason L. Hafstad. 2018. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservativism (CoC) Values for Species and Genera. New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ. Submitted to United States Environmental Protection Agency, Region 2, for State Wetlands Protection Development Grant, Section 104(B)(3); CFDA No. 66.461, CD97225809.

Wang, B., and Y. L. Qiu. 2006. Phylogenetic distribution and evolution of mycorrhizas in land plants. Mycorrhiza 16(5): 299–363.

Weakley, A. S. 2015. Flora of the southern and mid-Atlantic states, working draft of May 2015. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC.

Weatherby, C. A. 1942. Two weeks in southwestern Nova Scotia. Rhodora 44(523): 229–236.

Whittemore, Alan T. and Alfred E. Schuyler. Page updated November 5, 2020. *Scirpus longii* Fernald. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed August 7, 2022 at http://floranorthamerica.org/Scirpus_longii

Wisheu, Irene C., Cathy J. Keddy, Paul A. Keddy, and Nicholas M. Hill. 1994. Disjunct Atlantic coastal plain species in Nova Scotia: Distribution, habitat and conservation priorities. Biological Conservation 68(3): 214–224.