Eleocharis equisetoides

Knotted Spike-rush

Cyperaceae

Eleocharis equisetoides by Samuel Brinker, 2021

***Eleocharis equisetoides* Rare Plant Profile**

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

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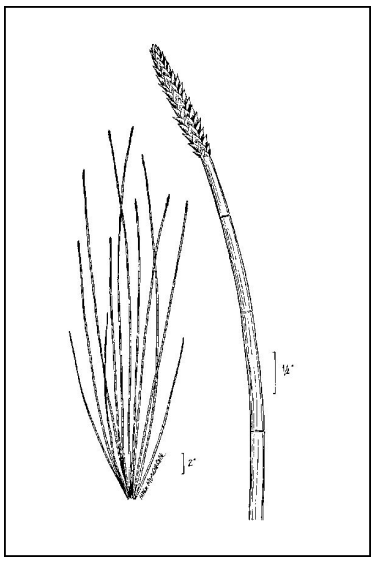
Life History

Eleocharis equisetoides (Knotted Spike-rush) is a rhizomatous perennial sedge. The species reproduces vegetatively, often forming extensive stands (Steyermark 1938, Dills 1973, Carter 2005), and some populations may consist of a single clone (Radford 1951, COSEWIC 2024). Meyer et al. (2006) indicated that vegetative spread occurs slowly in *E. equisetoides*.

Eleocharis plants have leafless stems that are sheathed at the base and end in a single spikelet. Torrey (1836) observed that the culms of *Eleocharis equisetoides* were "the size of a goose quill" (about 45–60 cm) but they can reach a meter in height. Knotted Spike-rush culms are mostly hollow but they are divided into partitions by thin membranes (septae), a feature which is relatively uncommon in the genus (Hinchcliff and Roalson 2009). The septae are spaced at distances of 2–5 cm, giving the stout, slightly rough culms a somewhat jointed appearance. The spikelets are 2–4 cm long, cylindric, and barely wider than the culms: They hold 85–160 floral scales. The yellow or reddish-brown achenes are 1.8–2.3 mm long and 1.4–1.9 mm wide and they are capped with dark brown, cone-shaped tubercles that are 0.6–1.1 high and 0.5–0.7 mm wide. A variable number of bristles (3–8) may be present or absent—if present they are generally shorter than the associated achene. (See Svenson 1920, Fernald 1950, Fassett 1957, Gleason and Cronquist 1991, Carter 2005, González-Elizondo 2020).



USDA NRCS 2024a.

Nate Martineau, 2019.

The culms of *Eleocharis equisetoides* continue to elongate throughout the growing season until late August (Polisini and Boyd 1972). In the northeast, flowering begins mid-summer and fruit is likely to be present from August to October (Hough 1983, NYNHP 2024) but in other parts of the species' range fruiting can start in the late spring (Howell 2015, González-Elizondo 2020, Weakley et al. 2022).

Worldwide there are about 200 species of *Eleocharis* and approximately a third of those occur in North America so similar species have been grouped into subgenera. *E. equisetoides* is in subgenus *Limnochloa*. Two other species that are found in New Jersey are also in subgenus *Limnochloa*: *Eleocharis quadrangulata* and *E. robbinsii*. The culms of *E. equisetoides* are

sturdy and round in cross-section while those of *E. quadrangulata* are four-angled and those of *E. robbinsii* are slender and three-sided. Although all three have spikelets that are barely thicker than the stems, *E. equisetoides* is the only one with septate culms (Tiner 2009, González-Elizondo 2020, Weakley et al. 2022). The three species can also be distinguished by their achenes (Fernald 1950, Singer et al. 1996).

Pollinator Dynamics

Eleocharis equisetoides is probably pollinated by wind. Wind is the predominant pollination mechanism for the majority of species in the Cyperaceae, although there are a few exceptions in scattered genera including *Eleocharis* (Goetghebeur 1998). Notable adaptations to wind pollination in the sedge family include large anthers, long filaments, and prominent stigmas (Zomlefer 1994). Sedges that are fertilized by insects generally have other modifications to attract pollinators: For example, *Eleocharis elegans* has showy, scented floral spikes (Magalhães et al. 2005). Goetghebeur (1998) indicated that sedges with insect visitors were usually pollinated by wind as well. Some insects, such as syrphid flies, are able to obtain pollen from *Eleocharis* species without aiding in cross-fertilization (Saunders 2018).

Cross-pollination is presumed for the majority of plants in the Cyperaceae. Most sedges improve the probability of cross-fertilization by developing female flowers in advance of male flowers and/or by achieving floral maturity in a bottom-to-top sequence (Goetghebeur 1998). However, the strategy may be less effective in clonal species. Observations of another clonal spike-rush (*Eleocharis mutata*) showed that the culms continued to elongate as they matured so that pollen from the later-developing staminate flowers was likely to fall on the stigmas of younger pistillate flowers in the same clump (Hill 1891). In some *Eleocharis* species the transfer of pollen within clonal clusters has been identified as a possible cause of reduced seed viability (Demeda et al. 2018, Gudžinskas and Taura 2021).

Seed Dispersal

Eleocharis achenes are likely to be dispersed by multiple means including gravity, animals, and water (Leck and Schütz 2005). The seeds of various *Eleocharis* species are consumed by ducks, geese, gulls, grouse, and shorebirds, often in large quantities (McAtee 1918, Fassett 1957). Martin and Uhler (1939) observed that the achenes of *E. equisetoides* are relatively large in comparison to those of other spike-rushes and that the species could be an important food source for waterfowl. Mottled Ducks (*Anas fulvigula*) sometimes consume considerable amounts of *E. equisetoides* achenes (Beckwith and Hosford 1957) and the fruits are also utilized by diving ducks including *Aythya valisneria* and *A. collaris* (Perry and Uhler 1982, Hoppe et al. 1986). Howard and Allain (2012) characterized *E. equisetoides* as a high value food source for waterfowl. The dispersal of viable seeds following ingestion by waterfowl is well-documented, although results vary widely depending on both plant species and seed retention time (Soons et al. 2008, Wongsriphuek et al. 2008, Farmer et al. 2017). *Eleocharis* seeds may also be transported by birds that utilize plant stalks for nesting material or by adherence to feathers and feet (Morton and Hogg 1989, Leck and Schütz 2005). In water, most *Eleocharis* achenes have a

relatively short flotation time but even seeds that do not remain afloat can be transported by water movement or by attachment to floating vegetative matter (Leck and Schütz 2005). Long-distance seed dispersal may be inferred from the recent discovery of *Eleocharis equisetoides* in Oklahoma at a site that is more than 240 kilometers from the nearest populations in Arkansas and Texas (Buthod and Hoagland 2017). Since *E. equisetoides* can readily regenerate from sections of its rhizomes (Wein et al. 1987) some vegetative dispersal can occur via the movement of rhizome fragments, which is known to be an effective and important means of distribution in aquatic settings (Boedeltje et al. 2004, Barrett 2015). When transplanted experimentally, *E. equisetoides* became established without difficulty (Kroeger 1990).

Seed banking has been documented in many *Eleocharis* species (Leck and Schütz 2005), and *E. equisetoides* has been found in seed banks both at sites where the species was present in the vegetation and at sites where it was not (Mulhouse 2004). Meyer et al. (2006) indicated that the seeds of *Eleocharis equisetoides* can germinate in water at, above, or below the sediment surface but no additional information was found regarding the germination and establishment requirements of the sedge. Most species of *Eleocharis* that have been examined lacked mycorrhizae, although there were a few exceptions (Wang and Qui 2006). Bohrer et al. (2004) reported that plants in wetlands can be colonized by mycorrhizal fungi on a seasonal basis.

Habitat

Throughout its range, *Eleocharis equisetoides* has been found in a wide variety of aquatic habitats at elevations from 10–500 meters above sea level (González-Elizondo 2020). Although *E. equisetoides* is generally a freshwater species (Tiner 2009), some collections have been made in coastal wetlands that experience low levels of salinity (Zomlefer et al. 2008). Low pH measurements (3.6–5.7) have been reported at some sites (Stuckey 1982, Wooten and Leonard 1984) but the spike-rush has also been found in hard-water kettle lakes (Hough and Fornwall 1988, Tracy et al. 2003).

Eleocharis equisetoides often grows as an emergent plant in quiet waters near the shorelines of lakes or ponds (Ward and Leigh 1984, Homoya et al. 1985, Reznicek and Catling 1989, Kost et al. 2010, Howell 2015, Buthod and Hoagland 2017) or in freshwater and marshes (Dutton and Thomas 1991, Reid 2021). The species has frequently been found in coastal plain ponds that are flooded on an intermittent or seasonal basis (Steyermark 1938, Breden et al. 2001, Johnson and Walz 2013, NYNHP 2024). Some of the sites have shallow but stable water throughout the growing season (Enser and Caljouw 1989) In other cases, *E. equisetoides* is likely to be found at lower elevations within the ponds where water is deeper and remains present for much or all of the growing season (Zaremba and Lamont 1993, Huffman and Judd 1998, Clewell et al. 2009, Schalk et al. 2010). Knotted Spike-rush can also become established in wetlands that have been created by beavers or humans (Dills 1973, Sorrie and Leonard 1999, Holm and Sasser 2008, Reid and Urbatsch 2012, Sorrie et al. 2006, Weakley et al. 2022).

The two extant *Eleocharis equisetoides* populations in New Jersey are growing in different conditions. The northernmost occurrence is located in shallow water near the edge of a fairly large lake. In the southern part of the state, the spike-rush has long been known from an

intermittent coastal plain pond where it often disappeared during periods of drought but rebounded after the water level rose again (Cavileer and Galligos 1982, Moore 2004, NJNHP 2024).

Eleocharis equisetoides may co-occur with other members of the genus including *E. obtusa*, *E. palustris*, *E. quadrangulata*, and *E. robbinsii* (Naczi 1984, Buthod and Hoagland 2017, NYNHP 2024). In sites where *E. equisetoides* is abundant or dominant it is often associated with floating-leaved plants (*Brasenia, Nelumbo, Nuphar, Nymphaea*) and bladderworts (*Utricularia* spp.). Other emergent associates may include *Eriocaulon aquaticum, Juncus* spp., *Panicum hemitomon*, *Persicaria punctata*, *Pontederia cordata*, *Sagittaria lancifolia*, or *Schoenoplectus* spp. (Naczi 1984, Zaremba and Lamont 1993, Huffman and Judd 1998, Holm and Sasser 2008, Howell 2015, Buthod and Hoagland 2017, Akinbi et al. 2022, NYNHP 2024). Eyles (1941) observed that *Eleocharis equisetoides* was a characteristic component of *Nymphaea odorata-Myriophyllum pinnatum* communities in Georgia. *E. equisetoides* is also a diagnostic associate of poor fens on the coastal plain where *Cladium mariscoides* is dominant (Breden et al. 2001).

Although many of the sites where *Eleocharis equisetoides* typically occurs are relatively open, Martin and Uhler (1939) observed that the species can be fairly tolerant of shade. The spike-rush has been found growing with various species of *Nyssa* and *Taxodium* (Steyermark 1938, Sieren and Warr 1992, Sorrie and Leonard 1999, Schalk et al. 2010, Akinbi et al. 2022). In Ontario, the only known *E. equisetoides* population was located in a thicket swamp community dominated by *Cephalanthus occidentalis* and *Cornus stolonifera* (Bickerton 2006).

Wetland Indicator Status

Eleocharis equisetoides 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 2024b)

ELEQ

Coefficient of Conservancy (Walz et al. 2020)

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

With the exception of a single population in southern Ontario, the global range of *Eleocharis equisetoides* is restricted to the eastern and central United States (COSEWIC 2024, POWO 2024). The map in Figure 1 depicts the extent of Knotted Spike-rush in North America.

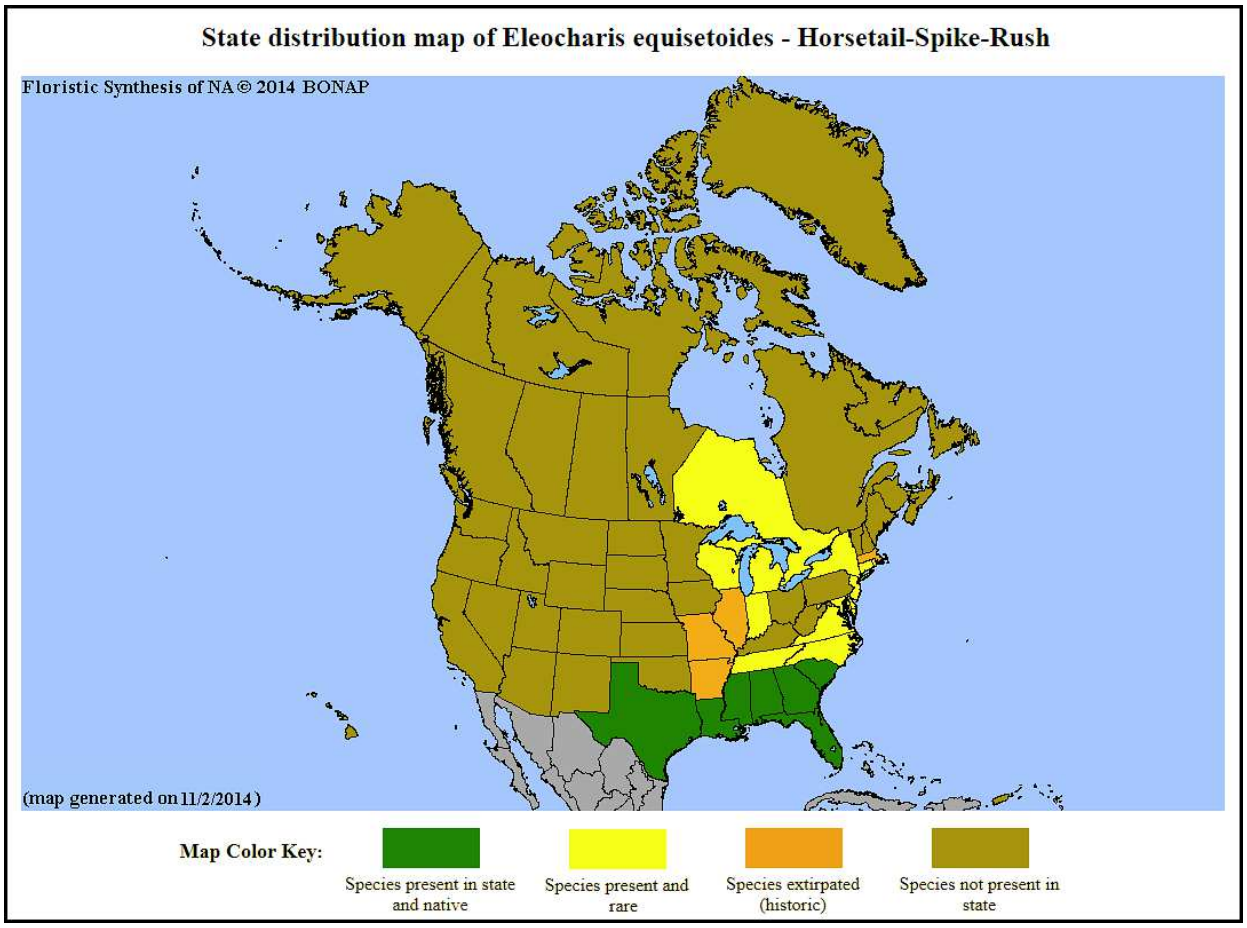


Figure 1. Distribution of E. equisetoides in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2024b) shows records of *Eleocharis equisetoides* in four New Jersey counties: Atlantic, Cape May, Cumberland, and Gloucester (Figure 2 below). Breden et al. (2006) made note of an extirpated occurrence in Salem County. The species has also been documented in Sussex County (NJNHP 2024). The data include historic observations and do not reflect the current distribution of the species.

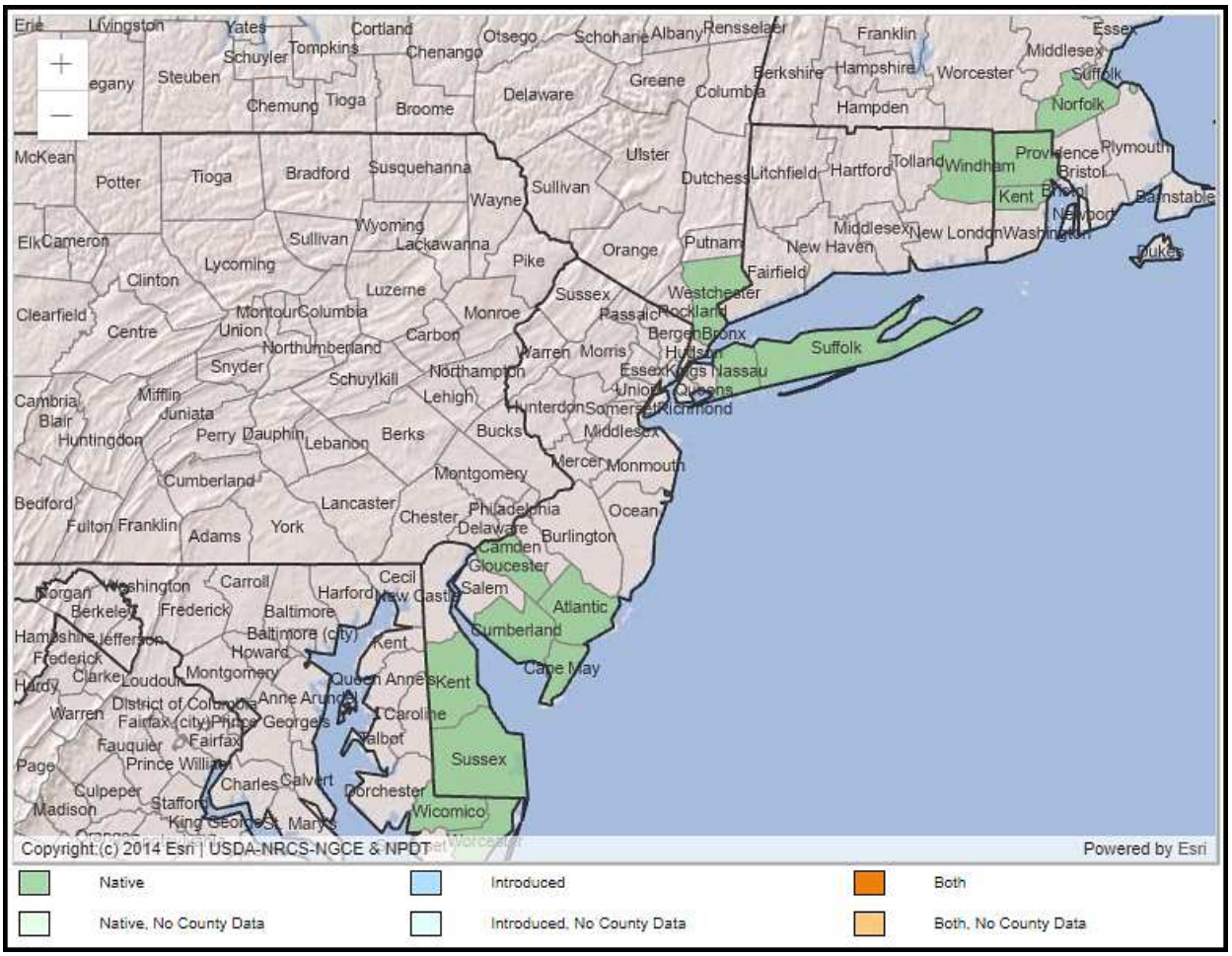


Figure 2. County records of E. equisetoides in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Eleocharis equisetoides is apparently secure at a global scale. The G4 rank means the species is at fairly low risk of extinction or collapse due to an extensive range and/or many populations or occurrences, although there is some cause for concern as a result of recent local declines, threats, or other factors (NatureServe 2024). The map below (Figure 3) illustrates the conservation status of *E. equisetoides* throughout its range. *E. equisetoides* is rare everywhere outside of the southernmost states and there is a notable gap in the center of its range. The sedge is vulnerable (moderate risk of extinction) in four states, imperiled (high risk of extinction) in three states, critically imperiled (very high risk of extinction) in nine states and one province, likely extirpated in Massachusetts and Missouri, and presumed extirpated in Illinois. Knotted Spike-rush is apparently secure in Florida and has not been ranked in four other states where it occurs.

Eleocharis equisetoides is listed as an endangered species in Canada, where the sole occurrence occupies an area of less than ten square meters and is thought to be a single clonal individual (COSEWIC 2024). At the continental level, *E. equisetoides* 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 rank of R3 (vulnerable), signifying a moderate risk of regional extinction (Frances 2017).

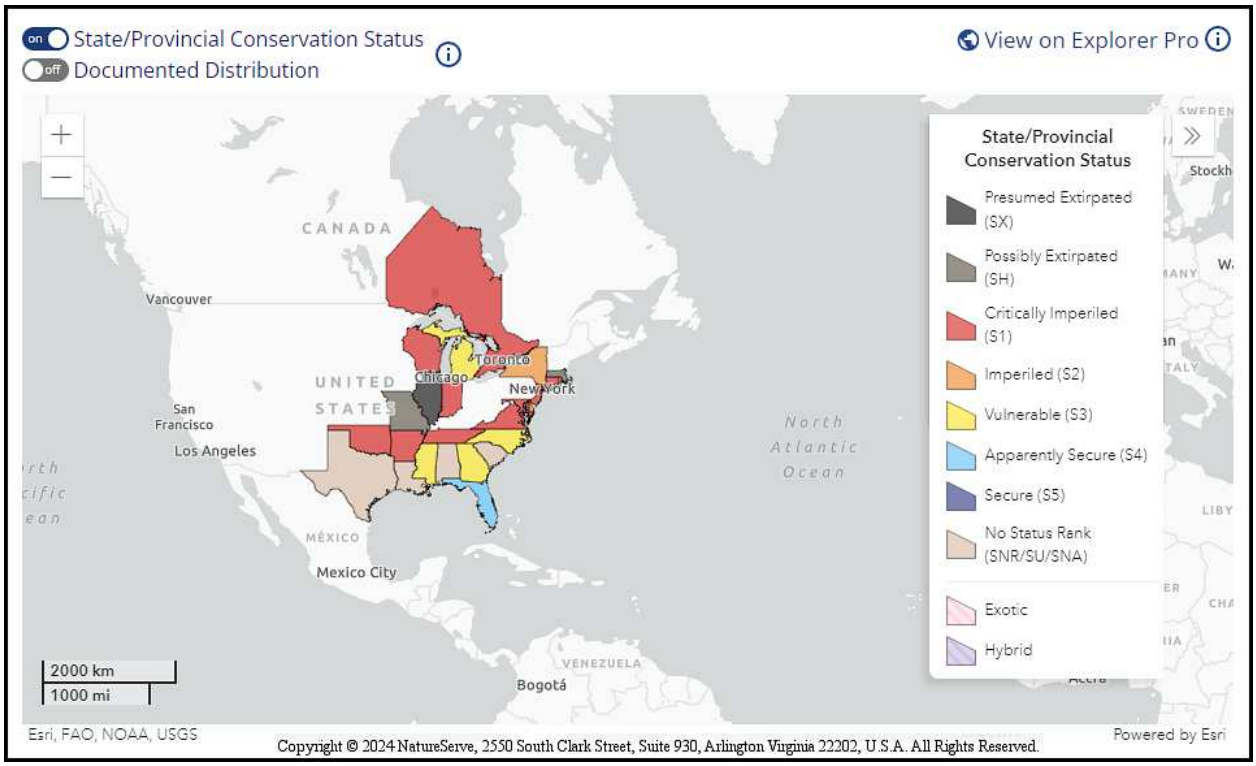


Figure 3. Conservation status of E. equisetoides in North America (NatureServe 2024).

Eleocharis equisetoides is critically imperiled (S1) in New Jersey (NJNHP 2024). The rank signifies five or fewer occurrences in the state. A species with an S1 rank is typically either restricted to specialized habitats, geographically limited to a small area of the state, or significantly reduced in number from its previous status. *E. equisetoides* 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 spike-rush 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).

Eleocharis equisetoides was first found in Gloucester County, New Jersey during 1892 and numerous collections were made from the site (Mid-Atlantic Herbaria 2024, NJNHP 2024), but it was last seen there during the early 1900s (Fairbrothers and Hough 1973). Fables (1956) included the spike-rush on a list of species thought to be lost to the state's flora but a new occurrence was discovered in 1960 (Snyder 2000). Fairbrothers and Hough (1973) categorized *E. equisetoides* as endangered in New Jersey because it was then only known from a single location in Atlantic County, although shortly thereafter Hough (1983) noted a current sight record for Cape May County. Knotted Spike-rush was one of the earliest plant species to be protected in the New Jersey Pinelands (NJ Pinelands Commission 1980). At some point two ponds where former occurrences had been documented were destroyed beyond redemption, but

the two populations of *E. equisetoides* currently known to be extant in the state appear to be fairly robust (NJNHP 2024).

Threats

Eleocharis equisetoides is sensitive to changes in water level (Treher 2022) and has been characterized as intolerant of drought (Meyer et al. 2006). The species tends to disappear from ponds when groundwater levels drop (Sieren and Warr 1992, Howard and Allain 2012) but long-term monitoring of a New Jersey occurrence indicated that the population size can appear to fluctuate significantly in response to water availability (NJNHP 2024). Bickerton (2006) suggested that *E. equisetoides* might rely on reserves in its rootstock to survive during dry spells instead of re-establishing populations from seed. In New Jersey a large, solid patch of plants was consistently found in the same location during wet years and since clonal growth occurs slowly in the species the observations support the idea that the plants can remain dormant when water is scarce.

Alteration or destruction of its wetland habitat is a threat to *Eleocharis equisetoides* throughout its range (Treher 2022). As previously noted, two of New Jersey's former populations were extirpated in that manner: At one site the pond was filled in and at the other it was deepened by dredging but the outcome was the same for the spike-rush (Breden et al. 2006, NJNHP 2024). Even habitats that remain structurally intact can become unsuitable as a result of changes in water quality or plant community characteristics. *E. equisetoides* colonized a Michigan site where it had not previously been seen after the dominant species (*Ceratophyllum demersum*) was eliminated by a drought. An overabundance of nutrients can foster dense growth of plants like *C. demersum*, inhibiting the establishment of many other species (Tracy et al. 2003). Invasive plants like *Phragmites australis* ssp. *australis* can also form monospecific stands in wetlands to the detriment of native flora, and the grass has been identified as a threat to *Eleocharis equisetoides* in Ontario (Bickerton 2006).

Waterfowl consume the achenes, stems, and roots of *Eleocharis* species and the roots are also eaten by muskrats (Fassett 1957). An analysis by Polisini and Boyd (1972) concluded that the stems of *E. equisetoides* were moderately digestible. Ingestion of achenes might result in dispersal but the consumption of stems and roots could eliminate plants. Grazing by waterfowl, particularly geese and swans, has been noted as a threat to *E. equisetoides* (Treher 2022, NYNHP 2024). In the southern United States, Nutria (*Myocastor coypus*) use *E. equisetoides* as a food source during the winter and spring (Atwood 1950). Nutria could jeopardize populations of the spike-rush in places where the two species co-occur because the animals live in colonies and tend to overeat their preferred foods in the areas where they reside (NJDFW 2015). Nutria appear to be expanding their range and the mammal has been identified as an emerging threat in New Jersey (FoHVOS 2023).

Climate Change Vulnerability

An assessment of the potential effects of climate change on selected plants determined that *Eleocharis equisetoides* was Moderately Vulnerable in New Jersey, meaning that its abundance and/or range extent within the state is likely to decrease by 2050. Noted risk factors included changes in hydrological patterns and sea level rise (Ring et al. 2013). The impacts could vary depending on the location of individual populations.

Consequences of changing climactic conditions in New Jersey include higher temperatures, shifting precipitation patterns that increase the frequency and intensity of both droughts and floods, and rising sea levels along the coast (Hill et al. 2020). Knotted Spike-rush thrives in the southern part of the country and can probably adapt to warmer temperatures. A study of vegetation exposed to effluent from a nuclear power plant found that *E. equisetoides* was most abundant in a pond that had not experienced any increase in water temperature, but a population was also present in another pond where the water temperature had been significantly elevated on a regular basis (Parker et al. 1973).

Occurrences of *E. equisetoides* in intermittent ponds are likely to be particularly susceptible to changes in hydrologic conditions (Johnson and Walz 2013). Although the species has some tolerance for seasonal water level fluctuations, droughts that persist through several consecutive growing seasons might exhaust the plants' capacity for regeneration. Paleoecological studies in a northern Indiana marsh determined that *Eleocharis equisetoides* had colonized the site between 5700 and 4500 years ago and disappeared about 2800 years ago. A rapid transition toward a drier climate occurred in the interim between the species' establishment and departure (Singer et al 1996, Jackson and Singer 1997).

Eleocharis equisetoides populations located near the coast may experience rising water levels or increased salinity. While the plants typically grow in shallow water, the species' capacity for withstanding extended periods of inundation is unknown (COSEWIC 2024). Increased soil salinity was suggested as a possible cause for a decrease in the abundance of *E. equisetoides* at a site near the southern coast of Louisiana (Howard et al. 2011).

Management Summary and Recommendations

Habitat protection is critical for the conservation of *Eleocharis equisetoides*. Both the quantity and quality of water appear to be important to the species' success. Buffers around ponds or lakes where the sedge occurs have been recommended to protect the natural hydrologic regimes of the aquatic systems (NYNHP 2024), and they can also help to limit the introduction of silt or other pollutants that reduce water quality. Because intermittent coastal plain ponds are especially vulnerable to lower water tables as a result of offsite activities, management of such sites may require cooperative efforts with owners of neighboring parcels or the formation of municipal partnerships so that protection of the habitats will be factored into regional development planning.

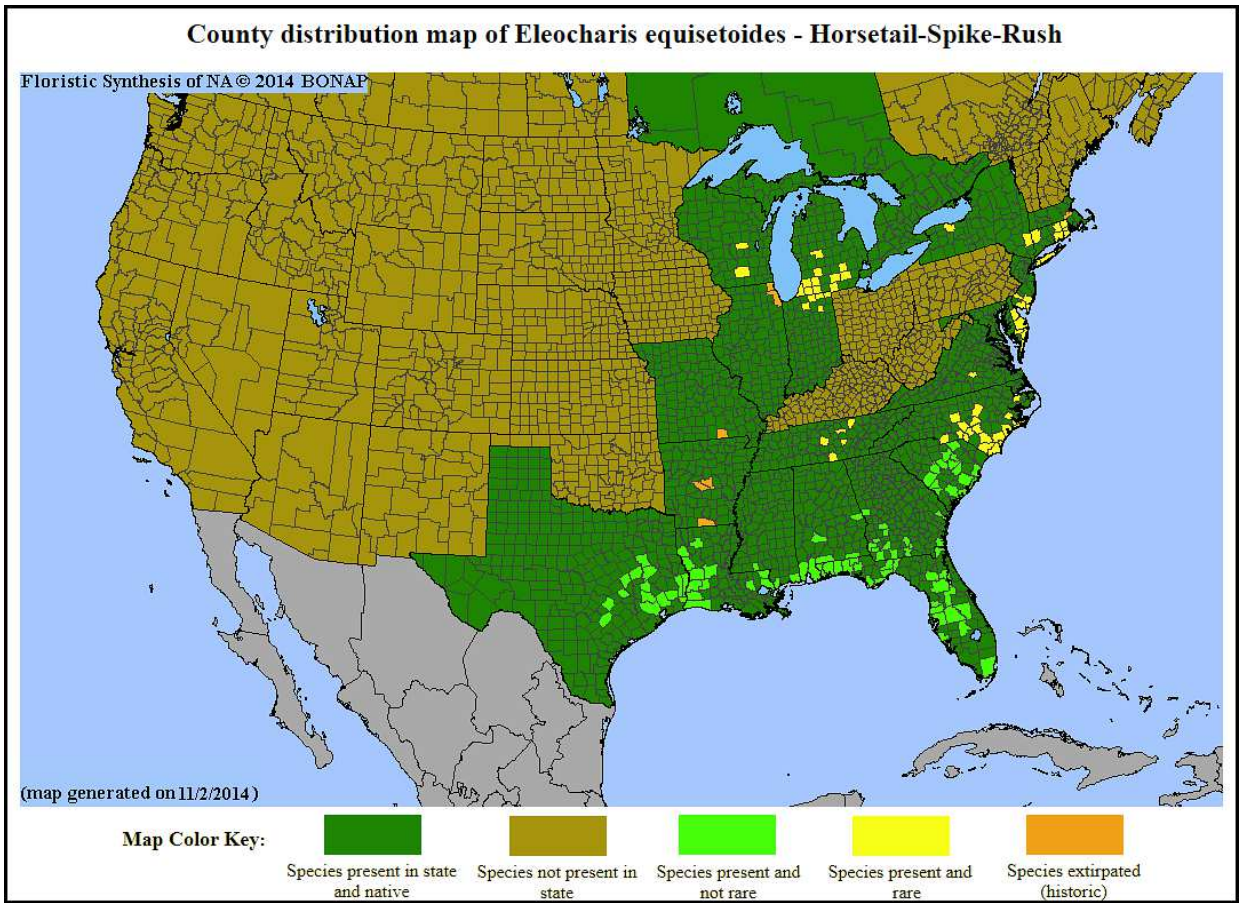


Figure 4. County distribution of E. equisetoides in North America, adapted from BONAP (Kartesz 2015).

The current distribution of *Eleocharis equisetoides*, illustrated in Figure 4, raises questions about the origin and spread of the species. The majority of occurrences are or have been located on the coastal plain and in the Great Lakes region but there have also been scattered occurrences in other physiographic provinces, including the recently discovered population in Sussex County, New Jersey. Despite having been present in northern Indiana for thousands of years (Jackson and Singer 1997), *E. equisetoides* has never been reported in Ohio and its complete absence from other states in the center of its range is also notable. Knotted Spike-rush is rare or extirpated in all but a few southern states and two of those (Georgia and Mississippi) now consider it vulnerable (NatureServe 2024). Additional research on *E. equisetoides* could result in a better understanding of the reasons for its relative rarity outside of the southern coastal plain. Potential topics for study include germination and establishment requirements; the extent of its ability to endure cold temperatures, salinity, or competition; and the length of time established plants can survive during periods of drought or inundation. It would also be useful to know whether fertility is reduced in clonally-formed colonies of *E. equisetoides*.

Synonyms

The accepted botanical name of the species is *Eleocharis equisetoides* (Elliott) Torrey. Orthographic variants, synonyms, and common names are listed below (ITIS 2024, POWO 2024, USDA NRCS 2024b).

Botanical Synonyms	Common Names
Eleocharis elliottii A. Dietr.	Knotted Spike-rush
Limnochloa equisetoides (Elliott) Walp	Jointed Spikesedge
Scirpus equisetoides Elliott	Horsetail Spikerush

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