

Species Listing PROPOSAL Form:
Listing Endangered, Threatened, and Special Concern Species in Massachusetts

Scientific name: *Pseudolycopodiella caroliniana*

Current Listed Status (if any): State Historic

Common name: Carolina bog false-clubmoss

Proposed Action:

☒ Add the species, with the status of: **Endangered**

☐ Remove the species

☐ Change the species' status to: _____

Change the scientific name to: _____

Change the common name to: _____

(Please justify proposed name change.)

Proponent's Name and Address:

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Association, Institution or Business represented by proponent:

Proponent's Signature:  Date Submitted: 2/23/2023

Please submit to: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, 1 Rabbit Hill Road, Westborough, MA 01581

Justification

Justify the proposed change in legal status of the species by addressing each of the criteria below, as listed in the Massachusetts Endangered Species Act (MGL c. 131A) and its implementing regulations (321 CMR 10.00), and provide literature citations or other documentation wherever possible. Expand onto additional pages as needed but make sure you address all of the questions below. The burden of proof is on the proponent for a listing, delisting, or status change.

(1) Taxonomic status. Is the species a valid taxonomic entity? Please cite scientific literature.

P. caroliniana (Syn. *Lycopodiella caroliniana*) is a valid taxonomic entity (Haines, 2011).

(2) Recentness of records. How recently has the species been conclusively documented within Massachusetts?

P. caroliniana was re-discovered in Massachusetts at two sites by the applicant in 2019. The [REDACTED] population was last observed in 2021; prior to this *P. caroliniana* was documented in the state by Harry Ahles (Ahles 1976, Consortium of Northeastern Herbaria Portal).

(3) Native species status. Is the species indigenous to Massachusetts?

P. caroliniana is regarded as being native to Massachusetts (NatureServe Explorer; Haines, 2011).

(4) Habitat in Massachusetts. Is a population of the species supported by habitat within the state of Massachusetts?

Yes, the habitat of *P. caroliniana* is present within Massachusetts. *P. caroliniana* is supported at two sites in North Central Massachusetts, where it is associated with acidic graminoid fens. This habitat type is present throughout Massachusetts, particularly in the central part of the state, with scattered occurrences on the outer Cape and in western Massachusetts.

The first documented occurrence of *P. caroliniana* was found growing in a “low, sandy area” along Plain Road in Hatfield (Ahles 1976, Consortium of Northeastern Herbaria Portal). This area was apparently an early successional habitat on sandy soil. Examples of this habitat type are found throughout the state.

P. caroliniana is known to inhabit interdunal swales further south in its range. This habitat exists in small areas on Cape Cod and the Islands. *P. caroliniana* has not been documented growing in interdunal swales in Massachusetts.

(5) Federal Endangered Species Act status. Is the species listed under the federal Endangered Species Act? If so, what is its federal status (Endangered or Threatened)

No, this species does not have federal status.

(6) Rarity and geographic distribution.

(a) Does the species have a small number of occurrences (populations) and/or small size of populations in the state? Are there potentially undocumented occurrences in the state, and if so, is it possible to estimate the potential number of undocumented occurrences?

The MA NHESP has documented a total of three occurrences of *P. caroliniana* in Massachusetts. Of these three occurrences, two are regarded as extant. Prior to its re-discovery, *P. caroliniana* was listed in the Flora Conservanda 2012 as Division 4 Regionally Historic Taxa .

The first documented population of *P. caroliniana* was located in the 1970's by Harry Ahles in Hatfield and is now regarded as historic. The two extant occurrences in Massachusetts are located at [REDACTED] and [REDACTED]. The [REDACTED] population encompasses an area of approximately one square foot; the [REDACTED] population is relatively robust and is diffusely present over an area of approximately 20'x20'. It is not possible to assess the number of individual genets present at either site since this species is capable of asexual reproduction.

P. caroliniana may be easily overlooked by botanists and field biologists due to its inconspicuous growth form and habitat preferences. The sites which host the two extant stations have been visited by botanists surveying vegetation of these peatland systems on numerous occasions (*Arceuthobium pusillum* and several WL species occur at both sites). At [REDACTED], *P. caroliniana* blends in with the associated *Sphagnum* species; in the warmer months, *Sphagnum* growth begins to overtake the *Pseudolycopodiella*. Additionally, these stations occur on floating peat mats which can be difficult to access. These factors may confound detection at other yet-to-be-documented stations.

The nearest known populations to the two in Massachusetts are located in interdunal swales on Long Island and in an acidic peatland just south of Lake George in New York State. The habitat of the Lake George population most closely resembles that of the extant populations in Massachusetts. Further south, *P. caroliniana* is predominantly found growing on sandy soils. Additional undocumented occurrences may exist in Massachusetts in similar habitats. Despite the potential for survey bias, it is unlikely that there are many additional populations in Massachusetts due to the rarity of suitable habitat.

(b) What is the extent of the species' entire geographic range, and where within this range are Massachusetts populations (center or edge of range, or peripherally isolated)? Is the species a state or regional endemic?

P. caroliniana ranges from Texas, along the Gulf Coast, Florida Panhandle, and up the Atlantic Coast (NatureServe Explorer). *P. caroliniana* in Massachusetts exists at the northern end of *P. caroliniana*'s distribution with only the Lake George NY population known to occur further north. The Massachusetts populations are the only occurrences documented in New England.

(7) Trends.

(c) Is the species decreasing (or increasing) in state distribution, number of occurrences, and/or population size? What is the reproductive status of populations? Is reproductive capacity naturally low? Has any long-term trend in these factors been documented?

The first documented population of *P. caroliniana* in Hatfield is believed to have been extirpated in a grading operation by the landowner (Pers. Comm. with Arthur Haines). This population is reported to have been fairly large in size.

Due to the recent re-discovery of *Pseudolycopodiella* in the region in 2019 it is not possible to estimate long term population trends. Both extant populations have been observed to produce strobili, however, the viability of spores has not been determined, and recruitment from sexual reproduction has not been observed.

(8) Threats and vulnerability.

(d) What factors are driving a decreasing trend, or threatening reproductive status in the state? Please identify and describe any of the following threats, if present: habitat loss or degradation; predators, parasites, or competitors; species-targeted taking of individual organisms or disruption of breeding activity.

The historic Hatfield population of *P. caroliniana* was extirpated by grading. Yet-to-be-documented populations occupying early successional habitat with sandy soils may be threatened by similar anthropogenic impacts.

Alterations to hydrologic cycles could result in degradation of *P. caroliniana* habitat. Anthropogenic influences, such as increased runoff from impermeable surfaces, or climate change induced drought, as well as natural influences, such as beaver activity, could negatively influence the viability of populations through the destabilization of water levels.

Beaver activity has been documented at both extant stations. Aerial imagery indicates that beaver lodges have been present at the [REDACTED] since at least 1995 (GoogleEarth). It is unclear whether beavers are having a positive or negative effect on the viability of these populations.

The [REDACTED] is located adjacent to a railroad and business park. *Typha* and *Cladium mariscoides* at [REDACTED] are present on the peat mat adjacent to these anthropogenic features and not the side opposite where *P. caroliniana* has been documented. This distribution is an indicator that these anthropogenic features may be having an effect on the composition of runoff entering into the system and altering pH and/or nutrient availability within [REDACTED].

Frangula alnus has been documented at both stations. While *F. alnus* does not appear to have become established on the peat mat, recruitment has been documented, and establishment has been documented in the adjacent shrub swamps. The establishment of *F. alnus* or other invasive species could pose a threat to the viability of *P. caroliniana* stations.

The small size of the Little Watatic Pond station makes it vulnerable to trampling and stochastic events.

(e) Does the species have highly specialized habitat, resource needs, or other ecological requirements? Is dispersal ability poor?

P. caroliniana is limited to acidic habitats with hydrologic influences, either peatland systems or early successional systems with wet sandy substrate. Broadly, these habitats are not uncommon throughout the state. At the extant stations, *P. caroliniana* appears to inhabit a specific sub-community within peatland systems. This sub-community is characterized by moss and sedge dominated lawns with *Sphagnum* spp, *Rhynchospora alba*, *Eriophorum virginicum*, *Juncus pelocarpus*, *Vaccinium macrocarpon*, *Carex limosa*, *Sarracenia purpurea*, *Pogonia ophioglossoides*, and *Drosera intermedia*. This sub-community occurs in depressions on unstable floating peat mats and is uncommon in Massachusetts. The presence of generally stable water levels may be necessary to support *P. caroliniana* at these stations. Habitat availability appears to play a role in the rarity of *P. caroliniana* in Massachusetts. It is unclear whether the Massachusetts populations of *P. caroliniana* are dispersal limited.

Conservation goals.

What specific conservation goals should be met in order to change the conservation status or to remove the species from the state list? Please address goals for any or all of the following:

- (a) State distribution, number of occurrences (populations), population levels, and/or reproductive rates
- (b) Amount of protected habitat and/or number of protected occurrences
- (c) Management of protected habitat and/or occurrences

I) Assess Site Characteristics and Viability of *Pseudolycopodiella* Populations in Massachusetts:

- a) Thoroughly assess the physical and biotic qualities of the two extant stations, including the pH of the water in these systems and sub-communities; degree of variations in seasonal water levels; and identity of associated *Sphagnum* and moss species.
 - i) Determine whether runoff associated with the parking lot and railroad west of the [REDACTED] station may be influencing the pH and nutrient availability of that system.
 - ii) Determine whether beavers are positively or negatively influencing the stability of water in these systems.
- b) Determine the ploidy of extant populations. Individuals of *P. caroliniana* have been documented to occur as diploids, tetraploids, and as sterile triploids resulting from interbreeding between the two (Bruce, 1976a). The presence of tetraploid populations would suggest that Massachusetts populations of *P. caroliniana* may be dispersal limited.
- c) Revisit the historic Hatfield site and document current soil, hydrological, and vegetative characteristics.

II) Increase Number of Known Occurrences:

Conduct *de novo* surveys at sites with habitat similar to that of the three populations known from Massachusetts. These surveys should identify and survey suitable early successional habitat in the vicinity of all three documented stations as well as in similar habitat statewide, with the goal of protecting 12 high quality sites which host *P. caroliniana*.

III) Management and Protection of Extant Stations:

Because *P. caroliniana* reproduces asexually it is not currently possible to count the number of genets at each station. As such the overall management for the species should focus on ensuring the viability of known stations by:

- a) Managing invasive species, including but not limited to *Frangula alnus* and *Phragmites australis*.
- b) Implementing management of beavers at the extant sites. This will largely depend on whether beavers are positively or negatively influencing the viability of extant sites. If beavers are found to stabilize water levels at these sites, their removal through trapping could prove detrimental to the viability of associated *P. caroliniana* populations.
- c) Augmentation of populations both on and off-site. The small size of the [REDACTED] station (<1 sqft.) makes it vulnerable to local extirpation through stochastic events and trampling or variations in water level. NHESP should consider propagating this population for outplanting at additional locations at the site to increase resiliency.

Literature cited, additional documentation, and comments.

Bruce, J.G. 1976a. Comparative studies in the biology of *Lycopodium carolinianum*. American Fern Journal 66(4):125-137.

Brumback, W. and J. Gerke. 2013. Flora Conservanda: New England 2012. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. Rhodora 115: 313-408.

Haines, A. 2011. Flora Novae Angliae: A Manual for the Identification of Native and Naturalized Higher Vascular Plants of New England. Yale University Press, New Haven and London.

NatureServe. 2023. NatureServe Network Biodiversity Location Data accessed through NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: February 23, 2023).

The Consortium of Northeastern Herbaria (CNH). 2023. Website (<https://www.neherbaria.org>). (Accessed: 2023-02-23).