

**Pickering's Morning Glory (*Stylisma pickeringii* var. *pickeringii*)
Five-Year Recovery Plan**

September 3, 2021

**Lee Minicuci
New Jersey Department of Environmental Protection
New Jersey Forest Service
Office of Natural Lands Management**



L. Minicuci, *Stylisma pickeringii* var. *pickeringii*

Objective

The New Jersey Forest Service, Office of Natural Lands Management (ONLM), seeks to restore viable populations of the State Endangered *Stylisma pickeringii* var. *pickeringii* (Pickering's morning glory) on state-owned properties in New Jersey. This initial five-year recovery plan includes monitoring, protection, and management of the 17 remaining occurrences in the state, and provides research recommendations to advance our understanding of the species' biology and the management activities needed to ensure its survival and recovery.

Background

Stylisma pickeringii var. *pickeringii* (hereafter referred to as *S. pickeringii*) is a vining herbaceous perennial belonging to the bindweed family, Convolvulaceae, and is native to the mid-Atlantic and southeastern U.S. There are currently two recognized varieties, var. *pickeringii* and var. *pattersonii*. Variety *pickeringii* is the only variety of *Stylisma pickeringii* present in New Jersey, otherwise existing from the Carolinas south to Georgia and west to Alabama, with New Jersey representing a northern population, disjunct and isolated from the southern range of the species. The variety *pattersonii* is found from Mississippi west to Texas and north through the Midwest to Iowa (Kartesz, 2015). Historically, botanists recognized four varieties of *S. pickeringii*, with var. *caesariensis* (now part of var. *pickeringii*) as a NJ endemic with an additional three varieties assigned to southern and western populations (Schuyler, 1990).

Conservation Status

Although *S. pickeringii* has a global ranking of G4T3 (vulnerable, but apparently secure throughout much of its range), in NJ it is ranked as S1 (critically imperiled due to extreme rarity), with a Coefficient of Conservancy value of 5, which indicates an intermediate range of ecological tolerances and some tolerance to anthropogenic disturbance (Walz et al., 2018; New Jersey Natural Heritage Program, 2020; NatureServe, 2020). Throughout the southern portion of its range, var. *pickeringii* is similarly imperiled, being ranked as S1 in Alabama, S2 in Georgia, S3 in North Carolina, and S1 in South Carolina (NatureServe, 2020). Threats to *S. pickeringii* within southern states include mechanical vegetation control of roadsides and utility corridors, military operations (on military bases), sand mining, and illegal off-road vehicle activity (R. Sutter, personal communication 8/1/2020).

Within New Jersey, *S. pickeringii* is known from scattered localities in the Pinelands of Atlantic, Ocean, and Burlington counties. The NJ Natural Heritage Program documents 17 naturally occurring, extant populations for the species, with 14 located on Department of Environmental Protection (DEP) properties. Records also indicate 10 occurrences have been lost and listed as “historic.” (Table 1). One historic occurrence was rediscovered in 2007, but not found since.

Notable threats include illegal off-road vehicle activity, intense fires, herbivory, invasive plant species encroachment, and natural succession. Several populations with over 100 plants in the 1980's and 1990's have been severely impacted by excessive vehicular traffic, invasive species encroachment, and illegal dumping and, as a result, have suffered dramatic declines in recent years (Schuyler, 1990; New Jersey Natural Heritage Program, 2020).

Species Description

S. pickeringii is sprawling and vining; the numerous, slightly pubescent stems of *S. pickeringii* are trailing and freely branching, growing 1-2m long and forming a roughly circular clump of extended stems surrounding the root crown. The roughly linear, often vertically borne leaves are alternately branched along the stem, and 3-6mm long with a tapering petiolar base. Leaf midribs are conspicuous and the leaf surface is slightly pubescent. The peduncles, bearing 1-5 pedicellate flowers, are as long or longer than the subtending leaves. Bracts are thin and 5-25mm in length. Sepals, 5, are ovate, 4-6mm long, densely villous and blunt tipped. The morning glory-like flowers are white, bearing 5 rounded lobes with corollas 12-18mm wide. There are five stamens with glabrous filaments; the ovary is densely pubescent. The 2 style branches are short (<3mm), unequal topped, and bear a knob-like stigma. *S. pickeringii* flowers profusely, producing hundreds of fruits, characterized by ovate-elliptic, thin-walled capsules (6 mm wide) with 1-2 seeds each. Seeds from var. *pattersonii* are produced in three colors – yellow, tan, and maroon; yellow seeds appear to be the most vigorous (Coons et al., 2003). Seeds of both var. *pickeringii* and var. *pattersonii* require scarification as well as bare sand in order to germinate (Coons et al., 2003). In var. *pattersonii* side shoots begin to develop roughly 7cm below the surface of the soil; development is linked to photoperiod and direct light is required in order for side shoots to begin growing (Kerber et al., 2000). *S. pickeringii* flowers and fruits from May to mid-August and is most easily identifiable during these life stages (Sorrie, 2010; Gleason & Cronquist, 1991; NatureServe, 2020; Weakley, 2015).

Ecology

Although its range is relatively widespread, *S. pickeringii* is confined to open, moderately disturbed sandy habitats such as sand road margins, sandhills and ridges, abandoned railroad beds, and paleodunes along the coastal plain. Its soil preference is that of xeric, sandy soils sparsely occupied by other competing plant species. *S. pickeringii* habitat generally consists of an extremely sparse (5-25%) *Pinus rigida*/*P. echinata* canopy with several meters between each bole, little or no shrub layer, and sparsely vegetated ground layer occupied by herbaceous and sub-shrub species such as *Hudsonia ericoides*, *Hudsonia tomentosa*, *Polygonella articulata*, *Triplasis purpurea*, *Panicum virgatum*, *Schizachyrium scoparium*, and clusters of the lichen genus *Cladonia* spp. Interestingly, suitable open habitat for *S. pickeringii* appears to be relatively common in the New Jersey Pine Barrens, but *S. pickeringii* occupies few of these sites.

Paleodune sand barrens include several globally rare ecological community types which form on these ancient sand dunes and provide ideal natural habitats for this species. The dunes were formed by wind action during the Pleistocene and gradually stabilized by surrounding vegetation, but the deep, xeric, nutrient-poor sand of the dune interior slows the rate of woody succession, allowing *S. pickeringii* to thrive for many decades after severe fire or disturbance with relatively little woody competition. Additionally, during intense fires the lack of fuel on a paleodune may spare *S. pickeringii*, while potential competitors encroaching on the dune margins are eliminated (Rudd & Sutter, 1996; NatureServe, 2020; Schuyler, 1990). Paleodune habitat often borders and mixes with *Pinus rigida* lowlands, wetlands, and floodplains, producing an ecotonal mosaic of habitats. Species from these bordering habitats such as *Liephyllum buxifolium*, *Gaultheria procumbens*, *Clethra alnifolia*, *Vaccinium* spp., *Gaylussacia* spp., and *Kalmia angustifolia* will often occupy small patches in between or bordering open paleodune habitat (Schuyler, 1990; Windisch, 2010; NatureServe, 2020). Pitch pine-sand myrtle lowland is a rare ecological community type often found in association with paleodunes of the central Pinelands which provides critical habitat for several rare Lepidoptera species (Schweitzer et al. 2011; Windisch, 2010).

S. pickeringii thrives in moderately disturbed environments and requires some form of disturbance, presumably to inhibit competitors, in order for its seeds to germinate (House, 2008). Until this disturbance takes place, a seed coat inhibits germination (Coons et al., 2003). The seed bank of var. *Pattersonii* remains viable for at least two years (Eastern Illinois University, 2004). However, some experimentation with storage methods suggests that seeds cleaned and subsequently stored at 40°F in paper bags within a refrigeration unit remain viable for at least 3 years (Charles Barecca, personal communication 6/3/2021; Barecca, 2020). The young seedling growth develops within a cavity of the seed, remaining underground where the new growth is protected from overly harsh conditions until subsequent growth develops the strength to penetrate above the soil surface (Sorrie, 2010). Seeds must undergo a process called scarification before they germinate, achieved through wind scouring, flooding, or even periods of intense heat (Coons et al., 2003). Artificial means of scarification include acid scarification (120-minute H₂SO₄ soak), 48-hour sandpaper shakes, 72-hour sand shake, and applications of hot water to the seeds, and result in high (85-100%) germination rates (Coons et al., 2003; Schuyler, 1990; Todd et al. 2002). Little to no germination occurs without scarification (Todd et al., 2002; Owen et al., 2002).

Several sources suggest that prescribed fire could serve as a means to aid in the colonization and spread of *S. pickeringii*, but little empirical data exists concerning the seasonal timing or intensity of a prescribed burn (Schuyler, 1990; House, 2008; Sorrie, 2010). Furthermore, there is some evidence that prescribed fire could adversely affect occurrences of *S. pickeringii* in the Pine Barrens, reportedly wiping out one small population (Schuyler, 1990). However, populations of *S. pickeringii* in Fort Bragg, North Carolina have been shown to benefit from a consistent prescribed fire regime that clears away encroaching vegetation, but the optimal timing and frequency of prescribed burning is still unknown (Rudd & Sutter, 1996). It is likely that low intensity prescribed burns during the late winter months could clear competing vegetation and spur germination without actively destroying the root systems of mature plants overwintering in the soil. Other actions to simulate disturbance include raking habitat to turn over mineral sand thus exposing dormant seed banks and encouraging germination. The

presence of *S. pickeringii* on many roadsides also suggests that a moderate amount of vehicle traffic adjacent to occurrences could have positive effects, exposing and scarifying dormant seed banks present in the soil (Schuyler, 1990). However, a historically large population at Hampton Gate was nearly destroyed by repeated ORV traffic and most other occurrences have been negatively impacted by ORV traffic.

S. pickeringii is monoecious and pollinated by a wide variety of insects. *S. pickeringii* plants in Georgia are reportedly visited by bumblebees (*Bombus* spp., Hymenoptera: Apidae) (Sorrie, 2010). The midwestern variety *pattersonii* was reported to have been visited by 47 insect species throughout its flowering period. Considering that the flowers of var. *pattersonii* and var. *pickeringii* are nearly identical and the insect communities fairly similar between Illinois and New Jersey, it is likely that occurrences in New Jersey support a similar number of insect pollinators. Insect species from five orders, Hymenoptera, Diptera, Orthoptera, Coleoptera, and Lepidoptera, were found visiting *S. pickeringii* var. *pattersonii* throughout the summers of 2001 and 2002. European honeybees (*Apis mellifera*, Hymenoptera: Apidae) and two species of bee fly (*Bombylius fraudulentus* and *Heterostylum croceum*, Diptera: Bombyliidae) were the most frequent visitors. Insect visits were more frequent during morning hours than afternoon hours and more insects visited during July than in June or August (Claerbout et al., 2010).

***S. pickeringii* 2019 Occurrence Monitoring**

In July and August of 2019, the New Jersey Department of Environmental Protection, Office of Natural Lands Management, in cooperation with the Pinelands Preservation Alliance (PPA) and New Jersey Conservation Foundation (NJCF), conducted a census of all 17 extant *S. pickeringii* occurrences in New Jersey. The results of this census, as well as details concerning the 10 historic occurrences are displayed in Table 1. While several occurrences have fared well, notably Batsto Fire Tower, a large number of occurrences have seen dramatic declines over the last 20 years.

***S. pickeringii* Propagation and Outplanting**

Rare plant propagation is a controversial subject in the conservation community. First and foremost, priorities for rare plant conservation should focus on preserving and protecting existing populations and the habitat they rely on, only utilizing rare plant propagation as a conservation strategy when all other options are exhausted. Any proposed propagation, augmentation, or reintroduction of a rare plant species needs to be well-justified and meticulously planned. Based on criteria developed to evaluate propagation and reintroduction proposals (Center for Plant Conservation 2019; New Jersey Department of Environmental Protection, 2021, Draft), there are multiple questions that must be addressed before a rare plant is considered to be a suitable candidate for propagation and outplanting.

- Is the species extinct in the wild? OR:
- Are the populations few, small, and declining? AND
- Have all other management options been considered, conducted, and judged to be inadequate? AND
- Is the species at high risk of extinction being managed *in situ*?

These questions help to determine if propagation and outplanting should be implemented. *S. pickeringii* is not extinct in the wild, and while a few populations are in decline, there are still 17 known occurrences found in New Jersey with several showing increases in population per the 2019 census. Furthermore, not all management options have been exhausted; prescribed burns and mechanical clearing of competing vegetation have yet to be implemented and evaluated for effectiveness. Finally, despite some shrinking occurrences, this species is not at an immediate risk of going extinct in the state.

Additionally, there are several criteria that, if met, would preclude this species from the need for propagation and outplanting (New Jersey Department of Environmental Protection, 2021, Draft). One criterion has been at least partially met for *S. pickeringii*: field surveys have not determined the true status of rarity of the species throughout its range. There is a considerable amount of potentially suitable habitat for this species in the Pine Barrens, much of which has yet to be surveyed. Comprehensive *de novo* surveys should be conducted before resorting to

augmenting existing wild populations or creating new experimental occurrences in suitable habitat. Moreover, the ecology and biology of this species, especially the disjunct occurrences of the subspecies found in New Jersey, are not well understood; literature on this topic is relatively lacking. Factors that could contribute to the success and failure of propagation as well as potential impacts and consequences of augmentation or introduction to a new site are poorly understood as well. Research should be conducted regarding reproductive biology, response to fire and mechanical clearing, and pollinator visitation to help further our understanding of this unique species and fill any gaps in knowledge. While the option for propagation and outplanting is not completely disregarded, it is not currently recommended in this recovery plan.

Restoration Plan Components

Recovery and management of *S. pickeringii* in New Jersey will have several components. The following four components are recommended for implementation by the ONLM from 2021 through 2025 to secure the continued existence of the species on state property managed by the Division of Parks and Forestry.

Monitoring

Annual or, at the very least, biennial censusing should occur at each of the known occurrences. Historic occurrences should continue to be surveyed for the presence of the species on a biennial basis. Surveys for *de novo* occurrences should take place every other year as suitable; previously unsearched habitat is relatively plentiful within the Pinelands. Monitoring will record the total number of plants and total number of stems as well as the number of plants bearing flowers and fruit, the number of flowers and fruits, the size and number stems arising from each root crown on the largest plants at each occurrence, and evidence of herbivory or other damage. Natural Heritage Rare Plant Species Reporting Forms (https://www.nj.gov/dep/parksandforests/natural/heritage/textfiles/NHRPSR_Form.pdf) should be completed for each known and historic occurrence surveyed.

Stylisma 2019 Surveys			
Site Name (Extant Sites)	Past/High Count	2019 Count	Notes
Lower Forge	1997: 133 plants	35 plants	
Crossley small	2016: < 10 plants	2 plants	buried under roadside vegetation
Crossley large	2008: 108 plants	150+ plants	
Batsto Fire Tower	1991: 207 plants	496 plants	
Ringler Road	none	3 plants	discovered 2015 private property
Whitesbog Reservoir	1991: 131 plants	20 plants	impacted by vehicular traffic
Whitesbog Village	1991: 210 plants	56 plants	Discovered 1931- threatened by illegal dumping
Whitesbog Spung	1991: 33 plants	11 plants	
Chatsworth Hunt Club	2015: 24 plants	28 plants	private property
Tulpehocken Creek Ridge	1999: 14 plants	101 plants	35 north/66 south
Carranza Memorial	1991: 47 plants	32 plants	
Ore Spung Branch	2015: 3 plants	15 plants	11 north/4 south
Carranza Rd (guardrail)	2006: 1 plant	2 plants	14 stems
Pleasant Mills Cemetery	N/A	9 plants	Discovered 1861
Hampton Gate	1985: > 400 plants	8 plants	impacted by illegal ORV activity
Friendship (Carranza Rd)	1991: 66 plants	8 plants	
Batsto River Railroad	1991: 41 plants	7 plants	Discovered 1903
Tulpehocken Creek Trib (RR)	N/A	2 plants	
Site Name (Historical or Extirpated)	Notes		
Batsto below the Forks	Single plant discovered 2007. Unable to relocate. Vehicle use/canoe launch site		
Quaker Bridge	Herbarium records 1828 & 1860		
Lakehurst	Herbarium record 1877		
Hammonton	Herbarium record 1882		
Chatsworth	Herbarium record 1885		
Pleasant Mills	Herbarium records 1866, 1881, 1888, 1905, 1910. Likely destroyed by canoe launch/gravel parking lot		
High Crossing	Herbarium record 1937		
Sandy Ridge	Single plant discovered 1984. Not found in 5 subsequent years		
Crowleytown	Herbarium record 1930		
Jenny's Island	Herbarium record 1946. Site likely destroyed during dredging of Mullica River		

Table 1: All known *Stylisma pickeringii* var. *pickeringii* occurrences, both extent and historical. Highlighted populations were protected from vehicular traffic using newly installed gates or railroad ties/downed trees in 2019. Crossley small and Crossley large are considered a single occurrence, but are differentiated here for management purposes.

Management

Proper habitat management and protection is crucial for maintaining *S. pickeringii*. Occurrences threatened by vehicular traffic should be protected; a good example is at Carranza Memorial where clusters of plants are surrounded with barriers of logs and railroad ties. Additionally, communication and coordination with mowing crews could save roadside occurrences threatened by mechanical vegetation removal. Known populations could be avoided during the time of flowering and fruiting. The site conditions of known occurrences could be maintained through a variety of techniques such as raking for soil disturbance, mechanical clearing to improve light availability and reduce fuel, and low intensity prescribed fire to reduce

competition and scarify seeds. Occurrences experiencing significant browse from herbivores could be caged or fenced. Experiments should also be conducted to test these strategies for habitat improvement, expansion, and creation.

Education

S. pickeringii is a noteworthy species found in a unique paleodune habitat formed by ancient dunes. Even more interesting is that New Jersey's populations is hundreds of miles disjunct from other populations. Public education on *S. pickeringii*'s unique life history and habitat could garner interest from the public and demonstrate just how much interesting plant life there is worth saving in the Pinelands and the state in general. It may be a good idea to produce additional media highlighting this species to draw attention to it.

Research

Much of the research regarding the biology of *S. pickeringii* was done on var. *pattersonii* which is not found in NJ. There is relatively little information concerning the biology and ecology of *S. pickeringii* var. *pickeringii* and even less on the specific populations here in New Jersey. There is very little data on long term viability of greenhouse propagated *S. pickeringii* and what data does exist indicates a significant difficulty in keeping plants alive for more than a year in captivity (Charles Barreca, personal communication 6/3/2021). Limited seed collection and greenhouse experiments testing scarification methods, seed viability, and germination requirements should be conducted to further understand the reproductive biology of the species. Greenhouse and scarification experiments could be contracted out to an institution such as Duke Farms, which already has some experience in storing and propagating rare plants, including *S. pickeringii* (Charles Barreca, personal communication 6/3/2021). In addition to greenhouse experiments, time should be taken to observe and identify insect visitors during the flowering period to gain a more complete understanding of pollinator dynamics concerning this species. Finally, as mentioned in the previous section, different management techniques should be experimented with and their results monitored for effectiveness.

Five-Year Activity Schedule

Year 1, 2021

- Establish cooperation with PPA, NJCF, Duke Farms, and any other pertinent agencies, organizations, universities, and non-profits that may have staff with the interest, expertise, and resources to assist.
- Conduct ecological community and rare species surveys in paleodune sand barren habitats planned for management, to evaluate best management practices for maintaining overall biodiversity during *S. pickeringii* management.
- Begin researching, planning, and acquiring permission for experimental management actions in small-scale pilot study units adjacent to extant *S. pickeringii* occurrences using raking and limited tree and shrub pruning.
- Add new barriers near Sandy Ridge Road to limit vehicle access into nearby extant *S. pickeringii* occurrences and sensitive paleodune sand barren habitats, as well as help maintain and restore these sensitive habitats so *S. pickeringii* occurrences can be expanded through management.
- Maintain previously installed gates on sand roads to Hampton Gate and Tulpehocken Creek Ridge occurrences to continue limiting vehicle access in these sensitive paleodune sand barren and pitch pine lowland habitats.
- Maintain any barriers (railroad ties, felled trees, etc.) installed next to *S. pickeringii* plants to protect occurrences from illegal ORV activity.
- Begin conducting experiments on seed stratification and germination:
 - Collect seeds from select *S. pickeringii* occurrences
 - Collect less than <5% of seeds from each occurrence
 - Collect and label soil from select *S. pickeringii* occurrences and suitable habitat
 - Roadside habitat
 - Paleodune habitat with/without *S. pickeringii* present
- Continue annual monitoring of existing and historic occurrences.
- Brainstorm educational media to garner public interest in recovery.

Year 2, 2022

- Conduct experimental management actions proposed in 2021 in small-scale pilot study units adjacent to extant *S. pickeringii* occurrences using raking and limited tree and shrub pruning.
- After completion of ecological and rare species inventories to help evaluate best management practices for maintaining paleodune sand barrens and overall biodiversity, begin planning any broader-scale habitat management/enhancement for the following year, including:
 - Mechanical thinning and/or raking to maintain open paleodune sand barrens or other early successional habitats.
 - Continue mechanical clearing and/or scarification to maintain/restore open paleodune sand barrens on heavily overgrown paleodunes.
 - Low intensity prescribed burning in small experimental plots to test fire's effectiveness in maintaining or restoring open paleodune sand barrens, overall biodiversity and *S. pickeringii* (But caution is recommended based on anecdotal accounts of negative effects from prescribed burning on these resources).
- Maintain previously installed gates on sand roads in *S. pickeringii* occurrences to limit vehicle access.
- Maintain barriers (railroad ties, felled trees, etc.) designed to protect occurrences from illegal ORV activity.
- Continue stratification and germination experiments
 - Subject seeds to different types of scarification (see Coons et al. 2003 and Owen et al. 2002):
 - 48- and 72-hour sandpaper shakes
 - 120-minute H₂SO₄ soak
 - Hot water application
 - No scarification (control)
 - Attempt to grow successfully germinated seeds in collected soils.
 - Collect and analyze data.

- Continue annual monitoring of existing occurrences and respond as needed to results.
- Conduct surveys for *de novo* occurrences.
- Conduct pollinator surveys at select occurrences.
- Create more media highlighting the current year's recovery efforts.

Year 3, 2023

- Conduct management actions proposed in 2022 (prescribed fire, raking, clearing) and begin planning any habitat management/enhancement for the following year.
- Continue to maintain previously installed gates on sand roads in *S. pickeringii* occurrences to limit vehicle access.
- Continue to maintain barriers (logs, railroad ties, felled trees, etc.) designed to protect occurrences from illegal ORV activity.
- Apply results of scarification/germination experiments to habitat management.
- Continue annual monitoring of existing and historic occurrences.
- Conduct pollinator surveys at select occurrences.
- Create more media highlighting the current year's recovery efforts.

Year 4, 2024

- Conduct management actions proposed in 2023 (prescribed fire, raking, clearing) and begin planning any habitat management/enhancement for the following year.
- Continue to maintain previously installed gates on sand roads in *S. pickeringii* occurrences to limit vehicle access.
- Maintain barriers (logs, railroad ties, felled trees, etc.) designed to protect occurrences from illegal ORV activity.
- Continue annual monitoring of existing occurrences.
- Conduct surveys for *de novo* occurrences.
- Create more media highlighting the current year's recovery efforts.

Year 5, 2025

- Conduct management actions proposed in 2024 (prescribed fire, raking, clearing) and begin planning any habitat management/enhancement for the following year.
- Continue to maintain barriers (logs, railroad ties, felled trees, etc.) designed to protect occurrences from illegal ORV activity.
- Continue annual monitoring of existing and historic occurrences.
- Analyze results of the last five years of research and monitoring, use results to develop a report on findings.
- Develop five-year plan for 2026-2031.

Literature Cited

- Barreca, Charles T. 2020. Propagation protocol for production of Container (plug) *Stylisma pickeringii* var. *pickeringii* Plants 7.25" plug; Duke Farms Foundation Hillsborough, New Jersey. In: Native Plant Network. URL: <http://NativePlantNetwork.org> (accessed 2021/08/12). US Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources.
- Center for Plant Conservation. 2019. CPC Best Plant Conservation Practices to Support Species Survival in the Wild. Center for Plant Conservation, Escondido, CA.
- Claerbout, Ann E., Todd, Brent L., Coons, Janice M., Owen, Henry R., Webb, Donald W., Ebinger, John E., McClain, William E. 2010. "Surveys of *Stylisma pickeringii* var. *pattersonii* (Convolvulaceae), its Associated Plant Species, and its Insect Visitors," *Rhodora*, 112(951), 228-243.
- Coons, J.M., Claerbout, A., and Owen, H.R. 2003. Seedbanks and Plant Development of *Stylisma pickeringii*, an Endangered Plant in Illinois. Illinois Department of Natural Resources, Springfield, IL.
- Eastern Illinois University. 2004. *Stylisma pickeringii*. Eastern Illinois University Department of Biological Sciences.
- Gleason, H.A. and Cronquist, A. 1991 Manual of Vascular Plants of Northeastern United States and Adjacent Canada. 2nd Edition, The New York Botanical Garden, Bronx, NY.
- House, Nash. 2008. *Stylisma pickeringii* var. *pickeringii*. Center for Plant Conservation, San Diego Zoo Global. <https://saveplants.org/national-collection/plant-search/plant-profile/?CPCNum=4157>
- Kartesz, J.T., The Biota of North America Program (BONAP). 2015. North American Plant Atlas. (<http://bonap.net/napa>). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)].
- Kerber, A.J., Owen, H.R., and Coons, J.M. 2000. Photoperiod impact on lateral shoot growth in *Stylisma pickeringii*. *Transactions of the Illinois State Academy of Science*. 93: 82.
- NatureServe. 2020. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://explorer.natureserve.org>.
- New Jersey Department of Environmental Protection. 2020 (draft). Rare Plant Propagation and Reintroduction: Questions and Considerations for Natural and Historic Resource Lands in New Jersey. Division of Parks and Forestry, Office of Natural Lands Management.

New Jersey Natural Heritage Program. 2020. Biotics 5 database. New Jersey Department of Environmental Protection, Office of Natural Lands Management, Trenton, New Jersey.

Owen, Henry R., Todd, Brent L., and Coons, Janice M. 2002. "Scarification Technique Affects Germination of *Stylisma pickeringii* (Patterson bindweed), an Illinois Endangered Plant." Faculty Research & Creative Activity. 88. http://thekeep.eiu.edu/bio_fac/88

Rudd, N. and Sutter, R. 1996. Monitoring Protocol for *Stylisma pickeringii*. In: *Monitoring for Rare and Endangered Species at Fort Bragg and Camp Mackall Military Reservations, North Carolina*. The Nature Conservancy, Southern Conservation Science Department, Chapel Hill, NC. 16pp + appendices.

Schuyler, A. E. 1990. Element Stewardship Abstract for *Breweria pickeringii* var. *caesariensis*. New Jersey Department of Environmental Protection and Energy, Division of Parks and Forestry, Office of Natural Lands Management. Stewardship Abstract No. 3. 6 pp.

Schweitzer, Dale F., Minno, Marc C. and Wagner, David L. 2011. Rare, Declining and Poorly Known Butterflies and Moths (Lepidoptera) of Forests and Woodlands in the Eastern United States. U.S. Forest Service. Forest Health Technology Enterprise Team. FHTET-2011-01. September 2011.

Sorrie, Bruce. 2010. *Stylisma pickeringii* var. *pickeringii*. Georgia Biodiversity Portal, https://georgiabiodiversity.a2hosted.com/natels/profile?es_id=21939

Todd, Brent L., Coons, Janice M., and Owen, Henry R. 2002. "Scarification Technique Affects Germination of *Stylisma pickeringii* (Patterson bindweed), an Illinois Endangered Plant," *The American Midland Naturalist* 148(1), 190-192.

USDA, NRCS. 2020. The PLANTS Database (<http://plants.usda.gov>, 5 March 2020). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Walz, Kathleen S., Linda Kelly, Karl Anderson and Jason L. Hafstad. 2018. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera. New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ, 08625. Submitted to United States Environmental Protection Agency, Region 2, for State Wetlands Protection Development Grant, Section 104(B)(3); CFDA No. 66.461, CD97225809.

Weakley, Alan S. 2015. Flora of the Southern and Mid-Atlantic States, Working Draft May 2015. University of North Carolina Herbarium.

Windisch, A. G. 2010. Rare ecological communities of the New Jersey Pinelands. Office of Natural Lands Management, Division of Parks and Forestry, NJ Department of Environmental Protection.