Polygala curtissii

Curtiss' Milkwort

Polygalaceae

Polygala curtissii courtesy Alan Cressler (2015), Lady Bird Johnson Wildflower Center

***Polygala curtissii* 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

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

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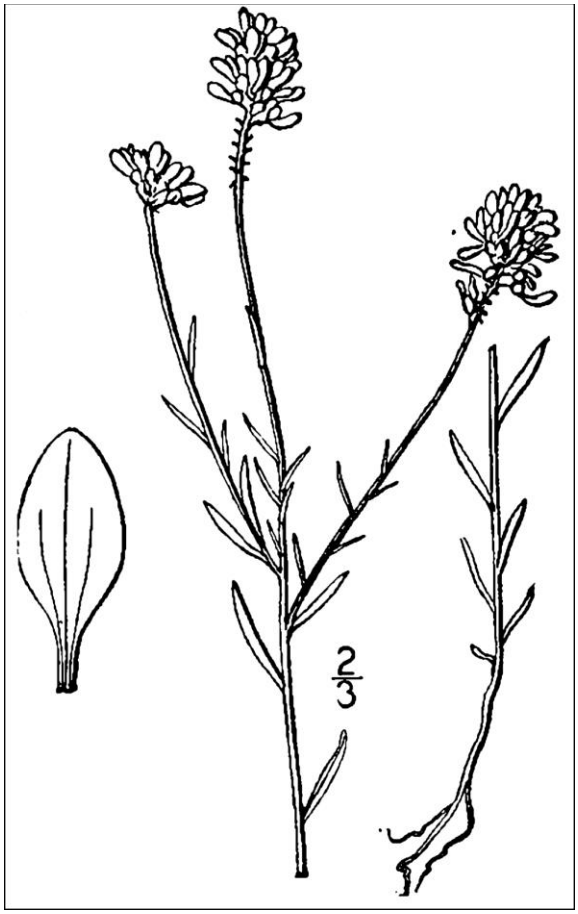
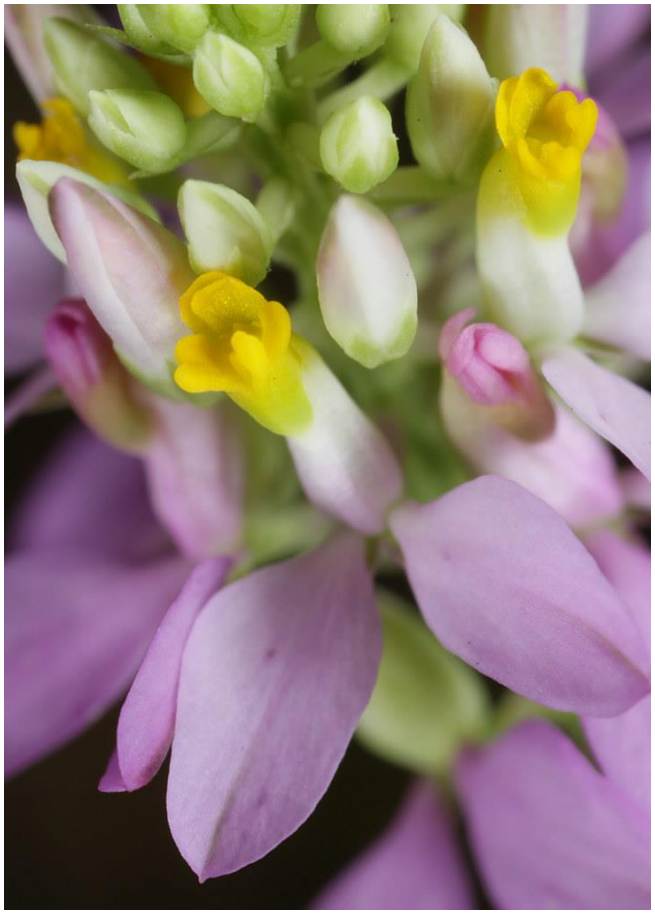
Life History

Polygala curtissii (Curtiss' Milkwort) is a small annual wildflower in the Polygalaceae. The plants have solitary, five-winged stems 10–40 cm in height with narrow alternate leaves that are 1–2 cm long. The inflorescence is a terminal spike-like raceme that is initially dense but loosens as the flowers mature. *Polygala* flowers have 5 sepals: Three are small and greenish but the other two (wings) are large, showy, and often brightly colored. In *P. curtissii* the wings are usually rose-purple but occasionally they are white. The small tubular flowers are positioned above the wings. *Polygala* flowers have three petals, the lowest of which is keel-shaped and crested at the tip, and the petals are fused to each other and also to the filaments of the stamens. In *P. curtissii*, the white or pinkish floral tube is approximately equal to the wings in length, and the small crest and other petal tips are bright yellow. The pistils and stamens are mostly concealed within the floral tubes. The fruits of *P. curtissii* are rounded capsules and, once they have fallen from the plants, tiny persistent bracts remain on the lower part of the flower stalk. (See Wheelock 1891, Britton and Brown 1913, Holm 1929, Fernald 1950, Gleason and Cronquist 1991, Weakley 2015, Abbott 2022). In the northern part of its range, Curtiss' Milkwort flowers and fruits from July through early October (Rhoades and Block 2007). In Georgia, the species was reported to have vegetative parts above the ground from mid-May through mid-December (Burbanck and Platt 1964).





Left: Britton and Brown 1913, courtesy USDA NRCS 2022a. Right: Cotinis, 2013.

Left: Persistent bracts, courtesy Bob Cunningham 2013. Right: Color variations, courtesy Alan Cressler (2014), Lady Bird Johnson Wildflower Center.

In New Jersey, there are several other small, alternate-leaved *Polygala* species that could be confused with *P. curtissii*. *Polygala mariana* (Maryland Milkwort) does not retain the floral bracts on its stems, the corolla of *P. sanguinea* (Purple Milkwort) is about half the length of the wings, and the racemes of *P. nuttallii* (Nuttall's Milkwort) are narrow (4–6 mm wide) in comparison to those of *P. curtissii* which are 8–14 mm wide (Fernald 1950, Gleason and Cronquist 1991, Weakley 2015).

Pollinator Dynamics

Zomlefer (1994) observed that "the pollination of *Polygala* species is complex and little-studied." Much of the complexity is due to the unusual structure of flowers in the genus. The style of a *Polygala* flower has two unequal branches. In *P. curtissii*, as in many other *Polygala* species, the shorter branch ends in a typical sticky stigma but the longer one is topped with a tuft of long hairs (Holm 1929). Holm found that a thin membrane is usually present in the area where the style divides, and while the shape varies between species it generally forms a pocket next to the short stigmatic branch. Pollen is released from the anthers through a single opening near the tip (Abbott 2022). In some cases, the pollen is captured in the hairs at the end of the longer style branch but in other instances it accumulates in the pocket adjacent to the stigma (Zomlefer 1994).

In some respects, *Polygala* flowers appear to be designed for insect pollination. The plants produce nectar and, in addition to the large and brightly colored wings, the crests on the keel petals may serve as visual attractants. When an insect lands on a crest it functions as a lever, moving the protective keel and exposing the previously released pollen to the visitor (Miller 1971, Howell et al. 1993, Westerkamp and Weber 2008, De Kock et al. 2018). No specific reports of insect pollinators were found for *Polygala curtissii*. Bees have been observed

nectaring or collecting pollen on several other kinds of *Polygala* including *P. sanguinea*, *P. polygama*, and *P. senega* (Borge 2017, Hilty 2020). Not all visitors fertilize the milkworts, though: Castro et al. (2013) found that of 24 insect species that visited the flowers of *Polygala vayredae* (an obligate outcrosser) only four were effective pollinators. A study of *P. vulgaris* concluded that many flowers in a population may remain unvisited because fluorescent dust experimentally applied to the anthers of 13 flowers was only dispersed from two. However, *P. vulgaris* is a self-compatible and largely self-pollinating species (Lack and Kay 1987).

Self-fertilization has been reported in many *Polygala* species although the strategies vary. Venkatesh (1956) reported that self-pollination was a regular occurrence in four Asian milkworts. In *P. abyssinia* the anthers adhered to the sticky stigma before dehiscence and shed their pollen on it as they opened. In the other species studied by Venkatesh, pollen was released directly onto the stigma due to curvature of the style prior to dehiscence. In *Polygala lutea*, a species where pollen is initially captured by the hairs on the longer style branch, it is later transferred to the stigma as the flowers age and the style branches curve toward one another (Miller 1971). Direct contact between the fertile and sterile stigmatic lobes also occurs in older flowers of *P. rugellii* but not in those of *P. lewtonii* (Weekley and Brothers 2006), so self-pollination cannot be counted on as a backup mechanism for all species of *Polygala*. Furthermore, Miller (1971) pointed out that such contact cannot be assumed to achieve self-fertilization because it depends upon the timing of stigmatic receptivity in an individual species.

With such a diverse array of pollination strategies employed throughout the genus, conclusions cannot be drawn regarding the likely fertilization strategy of any individual species. Consequently, the pollination dynamics of *Polygala curtissii* remain in question.

Seed Dispersal

The capsules of *Polygala curtissii* are 2.5–3 mm in diameter, roughly half as long as the adjacent wings. *Polygala* capsules have two chambers, each containing a single seed. *P. curtissii* seeds are small (1–1.5 mm long), dark brown, and densely hairy; and each seed has an aril-like outgrowth (elaiosome) with two lobes that extend for about one third of its length. (See Wheelock 1891, Holm 1929, Abbott 2022).

Polygala seeds are dispersed by ants, which utilize the elaiosomes as a food source (Zomlefer 1994, Forest et al. 2007). However, no specific ants have been identified as dispersers of *P. curtissii* seeds. Castro et al. (2010) studied ant dispersal of *Polygala vayredae*, a small perennial shrub in the milkwort family that is endemic to Spain. They found that seed dispersal distances varied significantly depending on the species of ant collecting the seeds because larger insects were able to carry the seeds farther. They also reported that not all ant-seed interactions were favorable to *P. vayredae*, as some elaiosome predation was observed and collection by one ant species that resided in tree trunks resulted in the deposition of propagules at sites that were not suitable for germination.

Even the largest ants observed by Castro et al. (2010) only moved *Polygala* seeds an average distance of slightly over 4 meters. Seeds of some plants, including *P. curtissii*, that colonized

early successional habitat patches on a granite outcrop may have originated in later successional patches elsewhere on the outcrop and been transported short distances by wind or surface runoff (Houle and Phillips 1988). Wyatt (1997) considered how species that colonize high elevation rocky outcrops are able to disperse their seeds over long distances to reach new locations with favorable habitat. Adherence to the feet of raptors and other birds that frequent outcrops was suggested as a possibility.

Very little information was found regarding the germination and growth requirements of *Polygala curtissii*. Curtiss' Milkwort was included on a list of plants with vesicular arbuscular mycorrhizae that were growing on an abandoned surface mining site in Tennessee, suggesting that the species may form fungal relationships in order to establish—at least in some environments (Rothwell and Vogel 1982). *P. curtissii* also turned up during an investigation of the seed banks of early successional communities on granite outcrops. Small numbers of the milkwort seeds germinated from soil samples collected on the study site after a three month period in cold, moist storage followed by a light/temperature regime designed to reflect that of the natural habitat (Houle and Phillips 1988). The results indicate that the species has some capacity for seed banking, although the length of time that the seeds may have been in the ground was not clear.

Habitat

Polygala curtissii is frequently found on high outcrops throughout the southeastern United States but also occurs at lower elevations on the coastal plain (Wiser 1994). Elevations from 0–1300 meters above sea level have been reported (Abbott 2022). At lower altitudes, *Polygala curtissii* can grow in sandy or clay soils of open woods, woodland borders, old fields, meadows, glades, thickets, and utility right-of-ways (Burns 1986, Weakley 2015, LeGrand et al. 2022, Abbott 2022). The milkwort has been found growing along sandy paths in a young *Pinus* woodland in Virginia (Vascott 1985), and New Jersey's population also occurs along a sandy path but is situated at the edge of an open thicket in a forest dominated by *Sassafras* and *Quercus* (NJNHP 2022). The habitats of *P. curtissii* are nearly always described as dry or dry to mesic (e.g. Rhoads and Block 2007, LeGrand et al. 2022, Abbott 2022), although an early description from one Kentucky site was an exception: Evans (1889) reported Curtiss' Milkwort growing on a substrate of level, layered black slate with poor drainage and very wet soil.

Harper (1939) included *Polygala curtissii* on a list of species that occurred on granite outcrops in Alabama, but several decades earlier he had provided some more detailed information about the habitat of one population. The milkwort was found on the highest summit of a steep hill with exposed patches of quartzite and gneiss, where it grew in a sparsely vegetated community under a very open stand of *Pinus palustris* (Harper 1906). In Georgia, when *P. curtissii* grows on granite outcrops, it can be found early successional habitats known as annual-perennial herb communities. The communities are the third successional stage of soil islands that form in depressions on the outcrops: The first stage is colonization by *Sedum smallii*, a winter annual, and the second stage is dominated by lichens and annual herbs (Burbanck and Platt 1964, Houle and Phillips 1988). The annual-perennial herb communities of the third stage include a mixture

of lichens, mosses, annual and perennial herbs, and occasional woody species (Burbanck and Platt 1964).

While *Polygala curtissii* is sometimes associated with natural early successional habitats such as rocky outcrops, Burns (1986) noted that the species can also occur in areas that have been highly disturbed and are nearly devoid of other vegetation. The abandoned surface mine in Tennessee may serve as an example: Curtiss' Milkwort established along with other early successional species less than twenty years after the resource extraction ended and the site was backfilled with acidic mine soils (Rothwell and Willis 1982). Other sites that have been utilized by *P. curtissii* also became open following disturbances. Rogers (1955) noted the species' occurrence on a rocky plateau in South Carolina that had been subject to regular burning prior to becoming a park. One study of post-fire successional communities in Great Smoky Mountains National Park found that *P. curtissii* was present in burned plots but not in unburned control plots. The species appeared to reach peak abundance on burned sites several years after a fire, then began to decline as succession proceeded (Harrod et al. 2000). Research at another location that had been subjected to a series of disturbances (including logging, burning, and the application of herbicides) yielded similar results for *Polygala curtissii*—the milkwort was absent from comparable undisturbed habitat in old growth *Pinus palustris* forest and grew only at the disturbed sites (Cipollini et al. 2012).

A shade-tolerance evaluation by Szakacs et al. (2022) determined that *P. curtissii* did not affiliate with any significant shade class association and categorized the species as a generalist in terms of canopy openness. The finding suggests that the milkwort's apparent preference for open sites could be influenced something other than a high light requirement. Some possibilities include the inhibition of seed germination by accumulated litter or a limited ability to compete for belowground resources.

Wetland Indicator Status

Polygala curtissii is not included on the National Wetlands Plant List (NWPL). Any species not on the NWPL is considered to be Upland (UPL) in all regions where it occurs. The UPL designation means that it almost never occurs in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2022b)

POCU5

Coefficient of Conservatism (Walz et al. 2018)

CoC = 6. Criteria for a value of 6 to 8: Native with a narrow range of ecological tolerances and typically associated with a stable community (Faber-Langendoen 2018).

Distribution and Range

The global range of *Polygala curtissii* is restricted to the eastern United States (POWO 2022). The map in Figure 1 depicts the extent of Curtiss' Milkwort in the North America. County level data indicates that New Jersey records of *P. curtissii* are limited to Cumberland County.

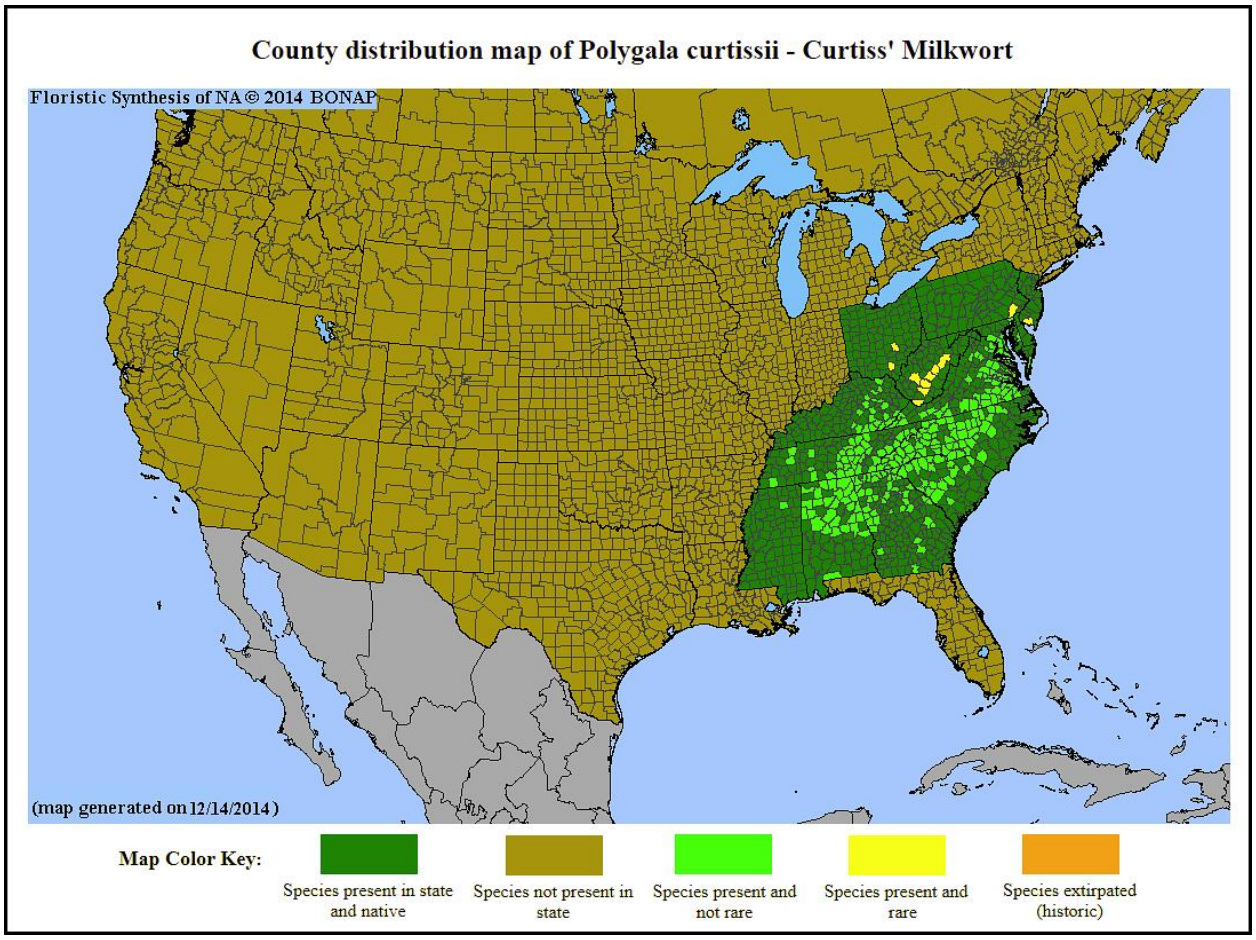


Figure 1. Distribution of P. curtissii in North America, adapted from BONAP (Kartesz 2015).

Conservation Status

Polygala curtissii is considered globally secure. The G5 rank means the species has a very low risk of extinction or collapse due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats (NatureServe 2022). The map below (Figure 2) illustrates the conservation status of *P. curtissii* throughout its range. The species is considered secure or is unranked in most of the southeastern states where it occurs, but is rare in the northern portion of its range. Curtiss' Milkwort is imperiled (high risk of extinction) in West Virginia and critically imperiled (very high risk of extinction) in New Jersey, Ohio, and Pennsylvania.

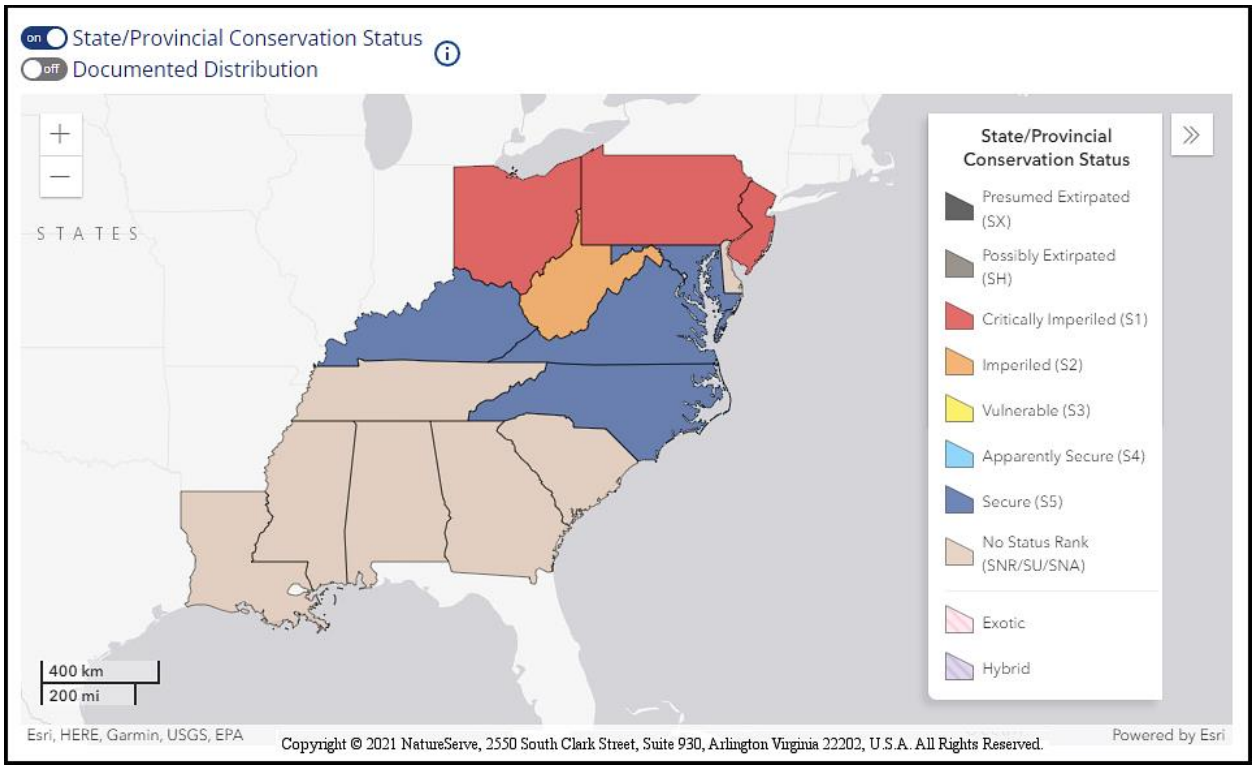


Figure 2. Conservation status of P. curtissii in North America (NatureServe 2022).

Polygala curtissii is ranked S1.1 in New Jersey (NJNHP 2022), meaning that it is critically imperiled due to extreme rarity. A species with an S1.1 rank has only ever been documented at a single location in the state. *P. curtissii* is also listed as an endangered species (E) in New Jersey, meaning that without intervention it has a high likelihood of local extinction. Although the presence of endangered flora may restrict development in certain communities, being listed does not currently provide broad statewide protection for plants. Additional regional status codes assigned to the plant 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). New Jersey's sole occurrence of *P. curtissii* is a small colony that was discovered in 2004 (NJNHP 2022).

Threats

No broad-spectrum threats have been identified for *Polygala curtissii*. The species is secure throughout most of its range and appears to tolerate a wide array of habitat conditions. Although it tends to disappear in later successional habitats, it seems to readily reestablish following canopy disturbance.

The status of *P. curtissii* is more precarious at the northern end of its range, where the species is known from a limited number of occurrences. In states where Curtiss' Milkwort is imperiled, small or isolated populations are more susceptible to extirpation. The locality of New Jersey's sole *P. curtissii* occurrence offers only a minimal amount of open habitat and it is heavily impacted by off-road vehicle (ORV) traffic. Notes from monitoring visits indicated that some of

the terrain at the site had been destroyed by ORVs (NJNHP 2022). Direct injuries to plants by ORVs can prevent completion of the reproductive cycle, while damage to the substrate can disrupt the seed bank and interfere with regeneration from stored propagules. On the other hand, some low-level disruption of adjacent habitat might create additional microsites that could be utilized by *P. curtissii*.

It is difficult to evaluate the potential effects of climate change on *Polygala curtissii* without a better understanding of what limits its presence at the northern end of its range. As a southern species, if its northern boundary has previously been restricted by climactic conditions then rising temperatures may create an opportunity for northward expansion. However, if the species' range has been limited by poor dispersal that is less likely to occur.

Management Summary and Recommendations

Like many other herbaceous and graminoid species, *Polygala curtissii* seems to flourish following a reduction in canopy density and leaf litter (Cipollini et al. 2012). In places where the species is well-established it may be able to naturally regenerate following a fire or other disturbance that opens the canopy and creates germination microsites.

The management priorities for the New Jersey population of *P. curtissii* appear to be maintaining an adequate patch of suitable habitat and protecting it from ORV traffic. The size of the colony has fluctuated significantly over the years, but so far the milkwort has been able to rebound when given the opportunity (NJNHP 2022). A site-specific plan should focus on strategies to maintain sufficient open space for the species to grow and spread, and on ways to minimize impacts from vehicles. While prevention of illegal ORV use has proven to be an insurmountable challenge in the state, it might be possible to redirect traffic around the *P. curtissii* occurrence.

Detailed life history information is lacking for *Polygala curtissii* and for many of the other *Polygala* species that occur in the region. Of the 13 native milkworts that have been documented in New Jersey, 7 are currently listed as imperiled, historic, or extirpated in the state (NJNHP 2022). Unfortunately, much of our current understanding of these plants is based on inferences and generalizations. Studies *of Polygala curtissii* are needed in order to determine its pollination strategy, identify its seed dispersal agents (both local and long-distance), and ascertain its germination and establishment requirements. Additional knowledge regarding the ways in which the climate may influence the species' life cycle and distribution would also be useful.

Synonyms

The accepted botanical name of the species is *Polygala curtissii* A. Gray. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA NRCS 2022b, POWO 2022).

Botanical Synonyms	**Common Names**
Polygala curtissii f. *alba* Moldenke	Curtiss' Milkwort

Polygala curtissii var. *pycnostachya* A. Gray — Appalachian Milkwort, Candyroot

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Cotinis. 2013. Curtiss' Milkwort flower detail. Licensed under CC BY-NC-SA 2.0 https://creativecommons.org/licenses/by/2.0 via Creative Commons.

Cressler, Alan. 2014. Photo of two color morphs of *Polygala curtissii*. Courtesy of the Lady Bird Johnson Wildflower Center, https://www.wildflower.org/. Used with permission.

Cressler, Alan. 2015. Cover photo of *Polygala curtissii*. Courtesy of the Lady Bird Johnson Wildflower Center, https://www.wildflower.org/. Used with permission.

Cunningham, Bob. 2013. Photo showing persistent bracts on a *Polygala* inflorescence. Used with permission.

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