Polemonium reptans var. *reptans*

Greek-valerian

Polemoniaceae

Polemonium reptans var. *reptans* courtesy Alan Cressler, Lady Bird Johnson Wildflower Center

***Polemonium reptans* var. *reptans* 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

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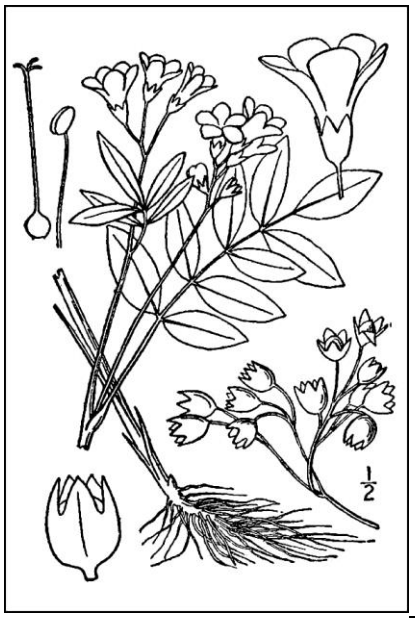
Life History

Polemonium reptans var. *reptans* (Greek-valerian) is a perennial herb in the phlox family. The stalks arise from a short rootstock so multi-stemmed plants grow in clumps. The smooth stems of *P. reptans* var. *reptans* may stand erect or lean sideways and they often branch near the top. The leaves are alternate and pinnately divided, usually with 11–17 leaflets but often fewer (3–5) near the top of the stem. The leaflets are up to 5 cm long and about half as wide. The branches end in small clusters of long-stalked flowers which are somewhat bell-shaped. The flowers are 1–1.6 cm long and have five sepals, five blue or light blue-violet petals, five stamens with creamy white anthers that are equal to or shorter than the corolla in length, and a slightly longer style that ends in three stigmas. The fruit is an ovoid capsule. (See Britton and Brown 1913, Keeler 1916, Fernald 1950, Wherry 1967, Gleason and Cronquist 1991).



Left: Britton and Brown 1913, courtesy USDA NRCS 2023a. Right: Courtesy Thomas L. Muller, Lady Bird Johnson Wildflower Center.

The morphological characteristics of *Polemonium reptans* var. *reptans* are somewhat plastic, and the species can vary in size, leaflet number and shape, sepal shape, or amount of pubescence (Wherry 1935, Braun 1956, Wilson 1960). However, the bluish, bell-like flowers in combination with the pinnate compound leaves make it fairly distinctive. Two other species of *Polemonium* have been documented in New Jersey (Kartesz 2015) and *P. reptans* var. *reptans* is closely related to both, but *P. caeruleum* and *P. vanbruntiae* have deep violet petals and stamens with yellow anthers that extend well-beyond the end of the corolla (Worley et al 2009). In states where *P. reptans* var. *villosum* is present that variety can be recognized by the dense cover of sticky-glandular hair on the stems, pedicels of the inflorescence, and young leaf stalks (Braun 1940, 1956).

Polemonium reptans var. *reptans* does not spread vegetatively (Baskin and Baskin 1992) although some gardeners have reported the successful propagation of the species by division of mature plants (eg. Hamblin 1922, Taylor 1998). New shoots are produced from the somewhat

woody crowns in the fall and persist throughout the winter months. Greek-valerian typically flowers in early spring over a period of a few weeks and the seeds are usually dispersed about a month later (Wherry 1935, Baskin and Baskin 1992). Both Stone (1911) and Hough (1983) reported that New Jersey plants begin to bloom in May but flowering in the state has been noted as early as April (Taylor 1998, NJNHP 2022). Observations recorded for one population indicate that the blooming period can vary considerably between years—for example in 2004 some plants were still in flower during early July but in 2008 all of the plants were in fruit by the end of May (NJNHP 2022). The flowering time reported for Pennsylvania ranges from April to August (Rhoads and Block 2007). After the plants have set seed the leaves remain for most of the summer (Benda undated).

Pollinator Dynamics

The stamens of *Polemonium reptans* mature before the pistils, which generally limits the likelihood of self-fertilization (Robertson 1891). According to Baskin and Baskin (1992), the species is self-incompatible and therefore dependent on pollinators. *P. reptans* flowers secrete nectar from discs at the base of the ovaries and attract numerous insects (Holm 2014). A wide variety of bees, flies, butterflies, skippers, moths and beetles visit the blooms (Robertson 1929, Hilty 2020). Bees are the most important pollinators of *P. reptans* and Lepidopterans can also contribute, but flies and beetles are less effective (Benda undated, Holm 2014).

Andrena polemonii is a specialist bee on *Polemonium* (Fowler 2016) although it appears to be a relatively rare species. Fowler and Droege (2020) reported it from Delaware and West Virginia, and it has also been recorded in Indiana and Minnesota (NatureServe 2023). Many generalist bees also visit *Polemonium* flowers, including species of *Andrena*, *Anthophora*, *Augochlorella*, *Bombus*, *Ceratina*, *Halictus*, *Lasioglossum*, *Nomada*, and *Osmia* (Stubbs et al. 1992, Williams and Winfrey 2013, Holm 2014).

Robertson remarked that he had never seen bumblebee (*Bombus* spp.) workers flying when *P. reptans* was in bloom, although he observed an assortment of female bumblebees (*Bombus impatiens, B. maculatus, B. pensylvanicus, B. vagans*) visiting the flowers (Robertson 1891, 1929). During a more recent study of foraging bumblebee queens, Macior (1968) documented very little contact between the bees and *P. reptans*. The data suggested that introduced plant species compete with native spring flowers for bumblebee queens.

Nevertheless, because Greek-valerian is able to utilize a variety of insects it does not appear to be pollen limited. When *Polemonium reptans* var. *reptans* was planted at a New Jersey site from which it had previously been eradicated the flowers attracted sufficient pollinators to produce fruit (Ruhren and Handel 2003). Williams and Winfrey (2013) examined the effects of urbanization on the pollination of *P. reptans*. Although the species was visited by more pollinators when growing in larger patches of woodland, landscape-scale habitat loss did not significantly reduce pollinator abundance or diversity. The authors concluded that gardens, parks and parcels of natural habitat in developed landscapes may help to maintain local populations of generalist pollinators, allowing plants that rely on insects to persist in smaller habitat patches.

Seed Dispersal and Establishment

Polemonium reptans var. *reptans* usually produces three seeds per capsule (Britton and Brown 1913) and an individual plant may have 3–80 capsules (Racke 2020). The seeds are 2–3 mm long and have no evident modifications for dispersal (Barak et al. 2017). The majority of *P. reptans* seeds are dispersed by gravity (Racke 2020), but when moist the seeds develop a mucus-like coating composed of numerous spiral threads (Keeler 1916) which could allow some distribution by attachment to the fur or feathers of animals (Howe and Smallwood 1982). The species is also dispersed by humans: *Polemonium reptans* has been in cultivation since the early 1700s (Wherry 1935) and is still popular with gardeners.

It is often noted that *Polemonium reptans* readily spreads by seed when growing conditions are suitable (Benda undated, Missouri Botanical Garden undated, Taylor 1998), but in unfavorable circumstances the seeds may germinate poorly or fail to germinate (Racke 2010). When Deno (1993) experimented with different maintenance regimes for *P. reptans* seeds the germination rates obtained were all below 50% and less than 2% for seeds that were kept in dry storage. Germination rates of 31–43% were recorded for seeds sown in greenhouse studies conducted by Baskin and Baskin (1992), and seeds that did not receive sufficient light or moisture were less likely to germinate.

When *Polemonium reptans* seeds are dispersed they are dormant and require a period of warm stratification to complete development. Seeds that ripen during the summer months can germinate in the fall. Seeds that do not ripen quickly can continue to mature throughout the winter months, but a period of cold stratification is not essential for the species (Baskin and Baskin 1992, 1998; Ahmad and Hitchmough 2007). Baskin and Baskin (1992) noted that Greek-valerian is one of just a few herbaceous perennials in our region with seeds that lose their dormancy in the summertime. During their study, 21–33% of the seeds that germinated did so during the fall, 65–78% germinated during the first spring, and 0–2% delayed germination until the spring of the following year. Because the vast majority of viable seeds develop within a year of dispersal *Polemonium reptans* is unlikely to maintain a seed bank.

Many forest herbs are mycorrhizal and that could also play a role in the establishment and persistence of *Polemonium reptans* plants. Although no studies of fungal associations in *P. reptans* were found, the closely related *P. caeruleum* is known to form mycorrhizae (Wang and Qiu 2006).

Habitat

Wherry (1935) remarked that *Polemonium reptans* was "extraordinarily adaptable to a variety of habitats" and suggested that one of the reasons the species was favored by gardeners was its tolerance for a wide array of growing conditions. It often occurs in moist, nutrient-rich soils in deciduous forests or along woodland edges but it has also been found in other moist habitats including meadows, prairies, and fens. In forested settings the plants may be situated in bottomland floodplains or on slopes (Keeler 1916, Wilson 1960, Hough 1983, Rhoads and Block 2007, Penskar and Crispin 2009, Chafin 2020, Weakley et al. 2022). Bray (1957) characterized

P. reptans as a climax forest species that was also able to establish in prairies but Olivero and Hix (1998) found that it was more abundant in second-growth forests than in old-growth forests. The plants grow best in places where they can receive some direct sunlight but are shaded for part of the day (Leopold 2005). One of New Jersey's populations is located in open woods on a riparian floodplain and another is situated both in an alluvial zone and on an adjacent slope (NJNHP 2022).

Wetland Indicator Status

The U. S. Army Corps of Engineers divided the country into a number of regions for use with the National Wetlands Plant List and portions of New Jersey fall into three different regions (Figure 1). *Polemonium reptans* has more than one wetland indicator status within the state. In the Eastern Mountains and Piedmont region, *P. reptans* is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands. In the rest of the state it is a facultative species, meaning that it occurs in both wetlands and nonwetlands (U. S. Army Corps of Engineers 2020).

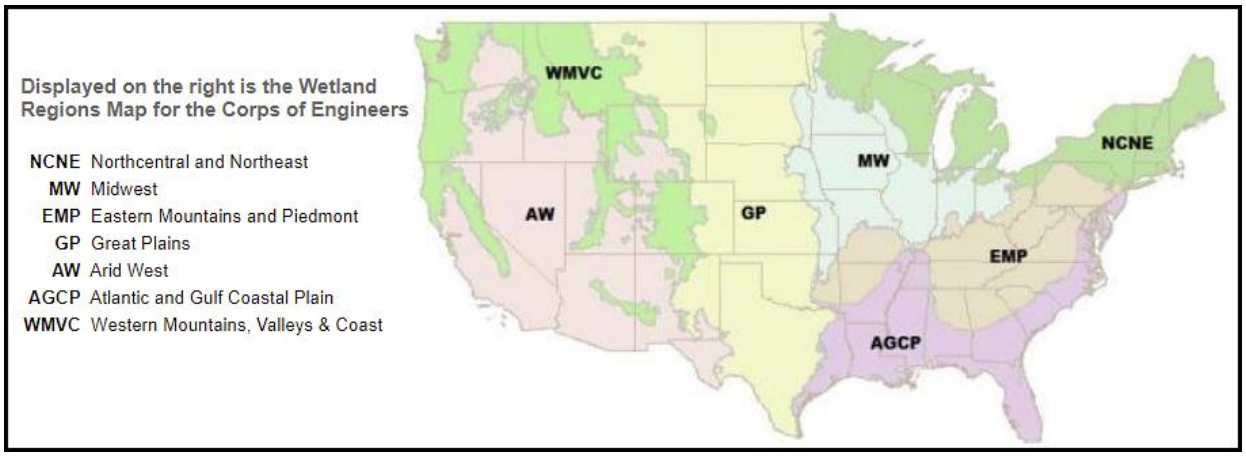


Figure 1. Mainland U. S. wetland regions, adapted from U. S. Army Corps of Engineers (2020).

USDA Plants Code (USDA, NRCS 2023b)

PORER

Coefficient of Conservatism (Walz et al. 2018)

CoC = 8. 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 *Polemonium reptans* var. *reptans* is restricted to the central and eastern United States and Canada (POWO 2023). The map in Figure 2 depicts the extent of *Polemonium reptans* var. *reptans* in North America. The other variety of *Polemonium reptans*, *P. reptans* var. *villosum* (Braun 1940), is only known from Kentucky and Ohio. There is some disagreement as to whether *P. reptans* is native (POWO 2023, USDA NRCS 2023b) or introduced (Kartesz 2015, NatureServe 2023) in Canada and northern New England.

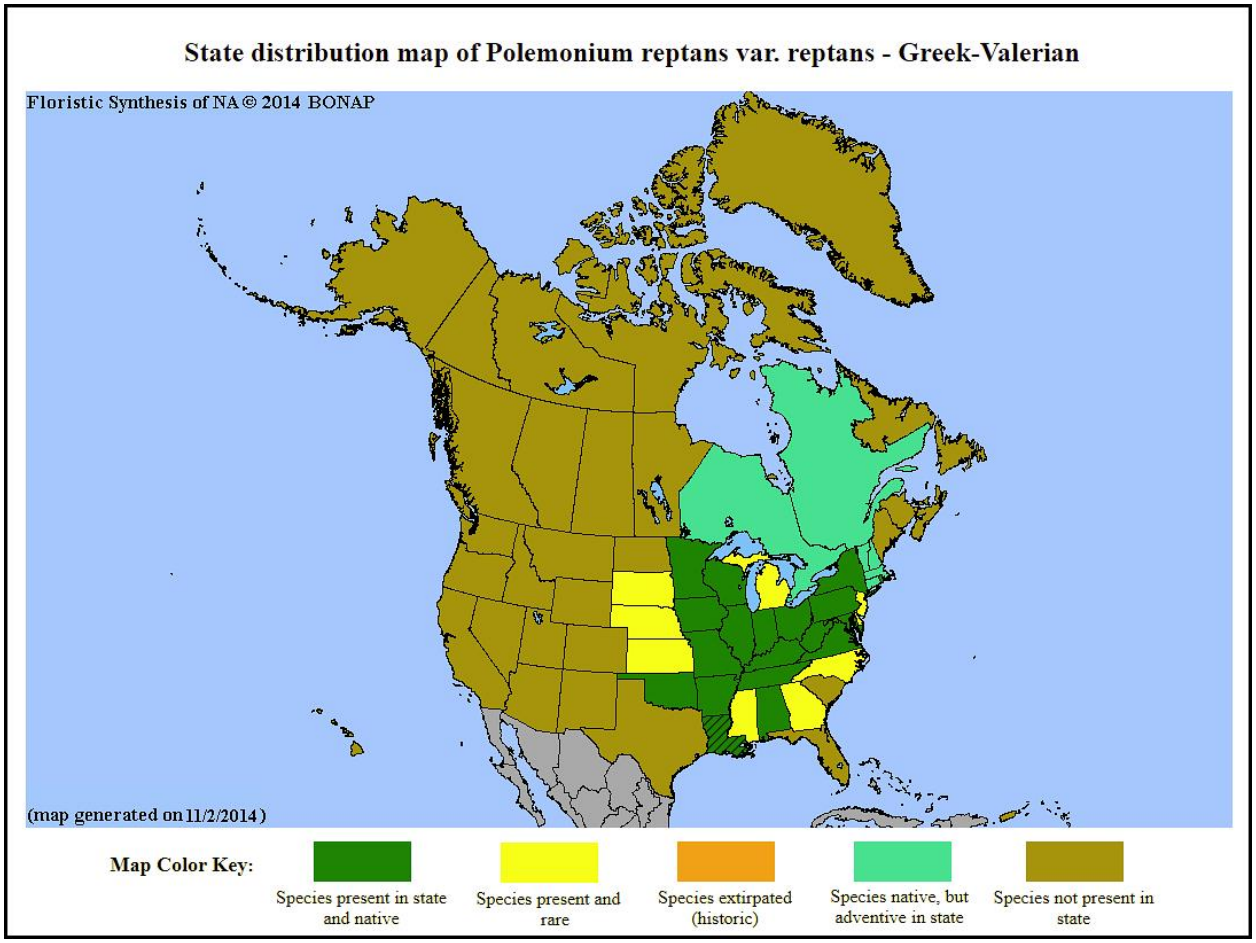


Figure 2. Distribution of P. reptans var. reptans in North America, adapted from BONAP (Kartesz 2015). Cross hatching /// indicates a questionable presence.

The USDA PLANTS Database (2023b) shows records of *Polemonium reptans* var. *reptans* in eight New Jersey counties: Burlington, Camden, Hunterdon, Mercer, Salem, Somerset, Sussex, and Warren (Figure 3 below). Collections have also been reported from Essex and Morris counties (Mid-Atlantic Herbaria 2023). The data include historic observations and do not reflect the current distribution of the species. Some records may reflect non-native occurrences, as *P. reptans* has long been popular with gardeners. Keeler (1916) remarked that the plant was "better known perhaps in the gardens than out of them" and Hough (1983) noted that the species was mostly found on the coastal plain but occurred as "an occasional escape" in the northern part of the state.

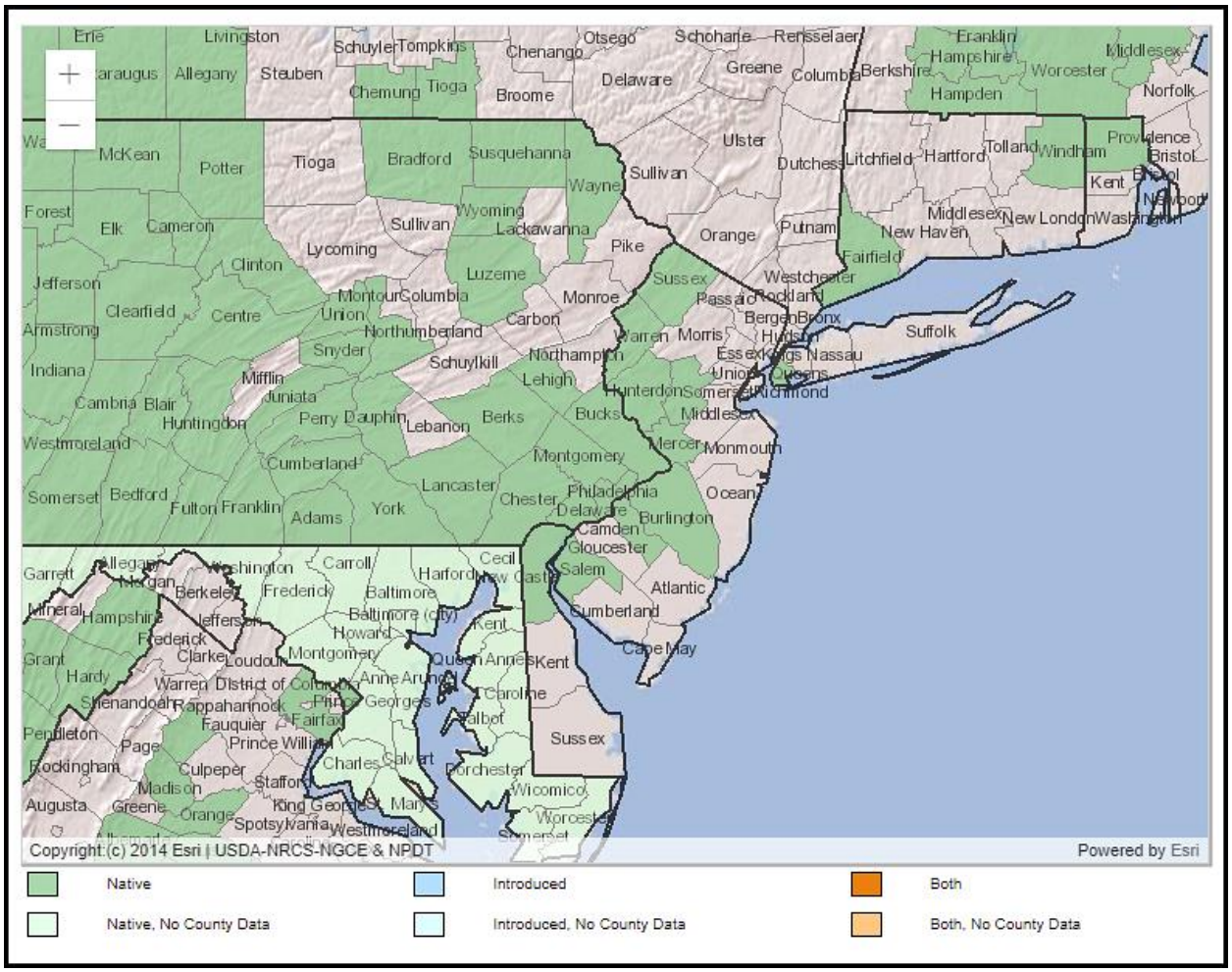


Figure 3. County records of P. reptans var. reptans in New Jersey and vicinity (USDA NRCS 2023b).

Conservation Status

Polemonium reptans var. *reptans* is considered globally secure. The G5T5 rank means the variety 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 2023). The map below (Figure 4) illustrates the conservation status of *P. reptans* var. *reptans* throughout its range. Greek-valerian is vulnerable (moderate risk of extinction) in one state, imperiled (high risk of extinction) in three states, and critically imperiled (very high risk of extinction) in four states. Throughout the rest of its native range it is secure, apparently secure, or unranked.

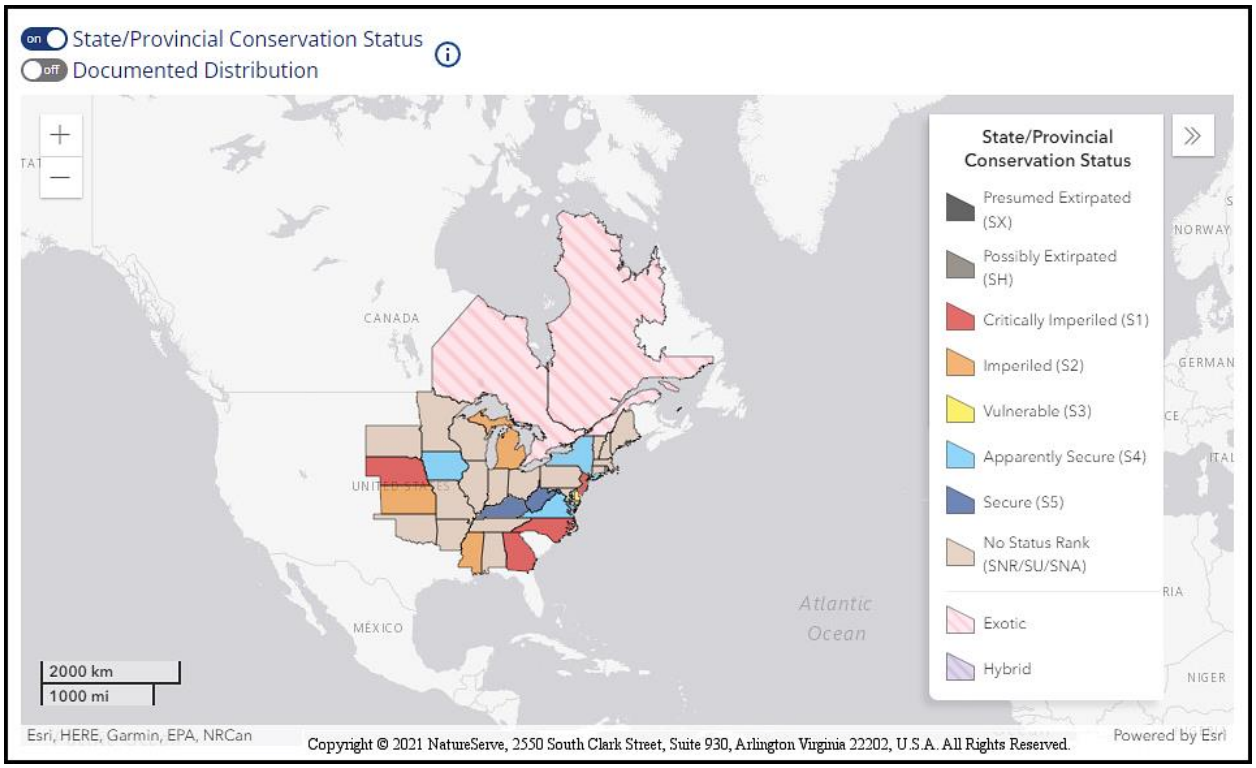


Figure 4. Conservation status of P. reptans var. reptans in North America (adapted from NatureServe 2023).

New Jersey is one of the states where *Polemonium reptans* var. *reptans* is critically imperiled (NJNHP 2022). The S1 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. *P. reptans* var. *reptans* 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, being listed does not currently provide broad statewide protection for plants. Additional regional status codes assigned to *P. reptans* var. *reptans* 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).

Polemonium reptans has never been abundant in New Jersey, and the majority of known occurrences have been situated in the Delaware River watershed (Britton 1889, Stone 1911, Taylor 1915). An 1892 specimen was collected at a Sussex County site in the Wallkill River watershed but there are no additional records of that population (NJNHP 2022). Breden et al. (2006) reported two extant occurrences in Salem County and those continue to be the only known populations remaining in the state.

Threats

Polemonium reptans var. *reptans* reaches the easternmost edge of its range in New Jersey and its presence in the state has always been somewhat tentative. Wherry (1935) remarked that— while

P. reptans was common and widespread further west—in New Jersey it "barely enters along the Delaware Valley." New Jersey's high human population density and the associated urbanization have probably prevented *P. reptans* from becoming more widely established throughout the state despite its reported capacity for utilizing a variety of habitats. At least one former occurrence was known to be extirpated by regional development (Breden et al. 2006). In Georgia, another state where *P. reptans* is critically imperiled, development continues to pose a threat along with the damming of streams and certain forestry practices (Chafin 2020).

Over the past three centuries, extensive horticultural usage of *Polemonium reptans* has probably contributed to the rarity of the species in the eastern part of its range. Plants like *P. reptans* which were valued by gardeners were often taken from their habitats and transplanted: In some cases entire populations of rare species were removed (Philadelphia Botanical Club 1958). Even when the plants were left to grow, the removal of seeds may have been especially harmful to species like Greek-valerian that rely on a relatively small number of propagules to maintain extant populations and establish new colonies. One early Philadelphia catalog that advertised *P. reptans* bragged that the vendor was "daily adding to his collection as he avails himself of every opportunity to procure seeds from all parts of America" (McMahon 1804). Even some who advocated for the protection of wild flora saw no harm in the removal of seeds: For example, Hamblin (1922) advised would-be propagators who found a patch of desirable plants to "mark the spot and return a month later to gather a goodly supply of seed." Despite regulations to the contrary, the poaching of native wildflowers continues to be a problem (USFS undated). The popularity of *Polemonium reptans* as a garden plant has not waned (Taylor 1988, Leopold 2005), and numerous cultivars have been developed (NCCE undated). The introduction of non-native genetic strains could also have a detrimental impact on natural populations.

Currently, the most evident imminent threat to *Polemonium reptans* var. *reptans* in New Jersey comes from invasive plant species. Ground Ivy (*Glechoma hederacea*) and Garlic Mustard (*Alliaria petiolata*) were both noted as abundant at one site, with the latter species being particularly robust and sometimes overtopping the *P. reptans* plants (NJNHP 2022). *Alliaria petiolata* is especially threatening to native communities because it produces secondary compounds that leach into the soil and inhibit the growth of fungi and associated flora (Kaufman and Kaufman 2007, Rose 2012). Other invasive plants have also been identified as threats to Greek-valerian throughout its range: *Lonicera japonica* and *Ligustrum sinense* were cited as menaces in Georgia (Chafin 2020), and non-native shrubs like *Berberis thunbergii* and *Lonicera tatarica* may compete with *P. reptans* for certain early spring pollinators (Macior 1968).

Polemonium reptans produces secondary metabolites known as triterpene saponins, which often provide plants with some protection against pathogens or herbivores (Gairola et al. 2010, Thimmappa et al. 2014). The compounds may make *P. reptans* somewhat distasteful, as the species is sometimes cited as a deer-tolerant garden plant (eg. Taylor 1998, Missouri Botanical Garden undated). However, there is plenty of evidence to the contrary so the local threat level from browsing may vary according to deer population density and the relative palatability of associated flora. Multiple studies have demonstrated significant impacts on *P. reptans* resulting from herbivory by White-tailed Deer (*Odocoileus virginianus*). An analysis of grazing intensity in Illinois found that browsing affected up to 63% of a Greek-valerian population and that the damage was most severe during early spring when the plants were in bud and in flower

(Frankland and Nelson 1999, 2003). Seed losses resulting from deer browse were as high as 96% in some West Virginia populations evaluated by Flaherty et al. (2017). By feeding seeds to captive animals and examining their pellets, Flaherty (2014) determined that the consumption of fruiting plants by deer does not result in the dispersal of viable *P. reptans* seeds. Consequently, deer herbivory can severely limit reproduction in an affected population.

Polemonium reptans is susceptible to *Uromyces acuminatus*, a rust fungus. Some types of *Uromyces* can complete their entire life cycle on a single plant species but others, including *U. acuminatus*, use alternate hosts—one of which is often a graminoid species (Jackson 1931). Early reports on the rust cited the alternate hosts as *Spartina michauxiana* and *Polemonium reptans* (Hasselbring 1912, Jackson 1917) and Mains (1933) successfully cultured spores that had been collected on *S. michauxiana* on *P. reptans*. Many rust fungi are narrowly specific in their ability to infect host plants but *U. acuminatus* has been reported on numerous species during both phases of its life cycle. *Spartina* species are often the graminoid hosts although other grasses have been reported, and the rust has been found on a wide variety of alternate hosts from multiple families, including some that were located in New Jersey (Tiffany and Knaphus 1984, Guatam et al. 2022). The fungus causes the formation of small rust-colored pustules that become surrounded by yellow rings as cells in the adjacent tissue die. The infection is often severe, resulting in a reduction of photosynthetic capacity and a consequent decrease in overall plant performance (Gautam et al. 2022).

Shifting climactic conditions are likely to increase the vulnerability of New Jersey's remaining *Polemonium reptans* populations. As the global climate changes, the state is experiencing higher temperatures, more frequent floods, and longer droughts (Hill et al. 2020). Past variation in blooming times suggests that *P. reptans* can adjust its flowering period in response to temperature, and even potted specimens have reportedly been able to tolerate extreme heat and rapid thermal fluctuations (Taylor 1998). However, Greek-valerian is sensitive to hydrologic alterations (Penskar and Crispin 2009). Cultivated varieties of *P. reptans* in an Alaskan garden were killed by a reduction in winter snow cover, which was apparently needed to maintain adequate moisture and shield the plants from extreme cold (Holloway and Wagner 1996). Low precipitation that led to relatively dry understory conditions in 1999 probably contributed to a decrease in the reproduction and survival of a New Jersey *P. reptans* population (Ruhren and Handel 2003). A decrease in moisture can also inhibit seed germination (Baskin and Baskin 1992). Intense storms that result in flooding may be equally damaging to the species. When populations monitored by Racke (2010) were inundated during mid-spring, fruiting *P. reptans* stalks withered and aborted seed production. The stress effects were observed after a single day of inundation and increased with flood duration.

Management Summary and Recommendations

Because *Polemonium reptans* var. *reptans* is critically imperiled in New Jersey, more frequent monitoring of the two remaining populations is recommended. One site where the species was noted as having a patchy distribution in a relatively degraded habitat has not been re-evaluated since 1988. The other site has been viewed more recently but the population should be checked for impacts from the invasive plant species that were previously reported as threats. Notes from

the latter site indicated that a shrub layer was lacking (NJNHP 2022), which could signify a growing threat from deer.

At sites where deer are a documented hazard to *Polemonium reptans* populations there are some strategies that have been used to reduce the threat in other locations. Browsing and associated reproductive losses were lower in sites where hunting was permitted (Flaherty et al. 2017). *P. reptans* plants grown inside exclosures that protected them from deer herbivory were taller, produced more numerous flowers and seeds, and had higher survival rates (Frankland and Nelson 1999, Ruhren and Handel 2003).

The impacts of competition on *Polemonium reptans* var. *reptans* do not appear to have been studied but a significant reduction in available light could inhibit seed germination. There are a number of additional areas where further research would be helpful in planning for management of the species including whether mycorrhizal associations are formed, the extent of cold tolerance, and the influences of temperature on flowering time. An evaluation of genetic variation in *P. reptans* could provide some insight into the adaptations of range-edge populations and help to predict the species' resilience as the climate continues to warm.

Synonyms

The accepted botanical name of the species is *Polemonium reptans* var. *reptans* L. Orthographic variants, synonyms, and common names are listed below (ITIS 2023, POWO 2023, USDA NRCS 2023b).

Botanical Synonyms	Common Names
Polemonium longii Fernald	Greek-valerian
Polemonium quadriflorum Raf.	Creeping Polemonium
	Spreading Jacob's-ladder

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