Dicentra eximia

Wild Bleeding-heart

Fumariaceae

Dicentra eximia by Charlie Eichelberger, PNHP

***Dicentra eximia* Rare Plant Profile**

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

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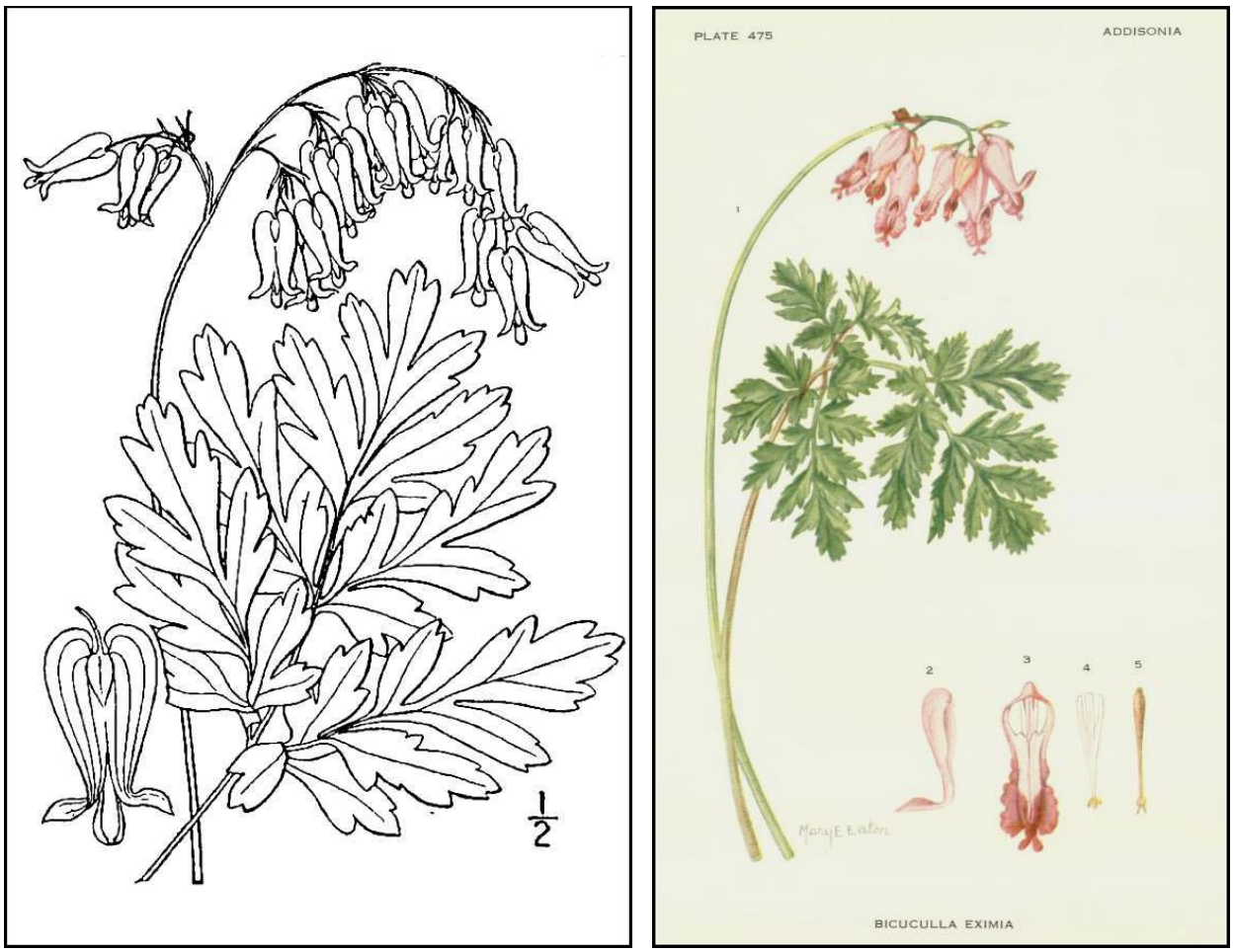
Life History

Dicentra eximia (Wild Bleeding-heart) is an attractive perennial herb in the Fumariaceae. Brooks (1911) described *D. eximia* plants as delicate and beautiful, and Rydberg (1929) remarked that it was one of the most beautiful native flowers he had ever seen. *Dicentra eximia* has stout, scaly rhizomes and finely divided (fernlike) basal leaves on long petioles that expand slightly at the base. The leaves may be up to 4 dm long but a spreading growth habit can make the plants appear as wide or wider than they are tall (Cahalan 2008, Longfellows 2024). The flowering stems of *Dicentra eximia* are leafless and usually longer than the leaves, terminating in an inflorescence composed of several small flower clusters on short branches. The calyx, a pair of small sepals that protect the developing floral buds, is discarded at blooming time. The corolla is bilaterally symmetrical and includes two pairs of petals. The large outer petals are about 2 cm long and they abut, together forming an elongate heart-like shape that ends in a pair of flaring lobes 4–8 mm long, while the inner petals are mostly concealed except for their crests which project beyond the lobes of the outer petals. The resulting structure creates an impression of a heart with a pendant droplet; hence the common name (Cahalan 2008, Gracie 2012). *D. eximia* flower colors may vary from deep rose-purple to pink, or occasionally white. The fruits are oblong to ovoid capsules 18–22 mm in length. (See Britton and Brown 1913, Rydberg 1929, Fernald 1950, Stern 1961 & 2020, Gleason and Cronquist 1991, Tebbitt et al. 2008).



Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Right: Mary Emily Eaton, 1929.

Stern (1961) noted that some *Dicentra* species only appear for a few months but others remain active for about two-thirds of the year. *D. eximia* falls into the latter category. Flowering in natural settings can occur from late spring until early fall, with fruit set beginning in the summer (Stern 2020, Weakley et al. 2024). The onset of flowering may vary with latitude: In Georgia first flowering dates were recorded during late March and early April (Funderburk and Skeen 1976), Hough (1983) reported April to late June as the blooming period for New Jersey plants, and in New York May through early August was noted as the species' flowering period (Mower and Lee 2003). Cultivated plants sometimes continue to bloom through October or until the first hard frost (Houser 2009, Tebbitt et al. 2008). In warmer climates *D. eximia* may bloom in spring and fall but pause during the hottest part of summer (NCCE 2024).

Houser (2009) categorized *Dicentra eximia* as an evergreen perennial because its leaves are generally present year round, but the foliage is replaced annually. *D. eximia* leaves remain identifiable throughout the fall and even in the winter although they may become wilted (eg. Murrill 1916, Edwards 1933). Eventually they die back to the crown, regrowing from the base in the spring (Longfellows 2024, NCCE 2024). Funderburk and Skeen (1976) observed that the production of new leaves in *D. eximia* preceded anthesis by approximately 2.5 weeks. Individual plants can be relatively long-lived (NatureServe 2024), persisting for about a decade in favorable conditions (Longfellows 2024).

Only two other native *Dicentra* species occur in New Jersey, *D. canadensis* and *D. cucullaria*. *Dicentra eximia* is not likely to be confused with either of those species: They both have white flowers, bloom very early in the spring, and shed their leaves as soon as the seeds have been dispersed. In addition to seasonality, white-flowered forms of *D. eximia* can be distinguished by the shape of the flowers and by its larger, thicker leaves (Gracie 2012). *Dicentra eximia* is most similar in appearance—and most closely related—to *D. formosa* (Ernst 1962). That species is native to the Pacific region of North America and has not been recorded growing wild in New Jersey, although it is present in some other northeastern states (Kartesz 2015). *D. formosa* has slightly broader flowers with shorter (2–5 mm) terminal lobes (Tebbitt et al. 2008, Stern 2020).

The attractive flowers and foliage and lengthy blooming period have made *Dicentra eximia* a popular garden plant, and the species sometimes escapes from cultivation and establishes in natural settings. The same is true of *D. formosa*, which sparked interest in the development of horticultural varieties. *Dicentra eximia* is a diploid species (2n=16) but *D. formosa* has more than one chromosomal variety, which probably explained the failure of early attempts to cross the two taxa. Several patented hybrids now exist and they are widely marketed for the garden trade, along with cultivars of both parent species (Rydberg 1929, Stern 1961, 1975, 2020; Hill 1992, Tebbitt et al. 2008). Some of the hybrid forms can spread aggressively via rhizomes (Cahalan 2008).

In addition to its horticultural importance, *Dicentra eximia* may have some utility for medical applications. Members of the family are generally rich in alkaloids (Ernst 1962) and toxic reactions have been reported from the consumption of *D. eximia* or after excessive contact with its sap (Stern 1961, New Moon Nurseries 2024). Following tests of seed extracts from 158 plant species, high antioxidant values were documented for *D. eximia* and antimicrobial activity against *Staphylococcus aureus* was reported (Borchardt et al. 2008).

Pollinator Dynamics

Stern (1962) examined the pollen morphology of *Dicentra* species and provided a description and illustration of *D. eximia* pollen grains. Many species of *Dicentra*, including *D. eximia*, are self-incompatible and rely on insects for cross-fertilization (Stern 1975, Schemske et al. 1978). Both the nectar and pollen of *Dicentra* flowers are enclosed within the tubular blooms so effective pollinators must be large and strong enough to push apart the petals and they must also have sufficiently long tongues to access the nectar at their bases. Bumblebees (*Bombus* spp.) are one of the few types of insects capable of pollinating *Dicentra* flowers (Stern 1961, Ernst 1962, Cahalan 2008). A video posted on social media by Edge of the Woods Native Plant Nursery (2018) shows a bumblebee pushing its way into *Dicentra eximia* flowers. The early-flowering *D. canadensis* and *D. cucullaria* are dependent on queen bumblebees for fertilization because the workers generally don't emerge until after those species have finished blooming (Macior 1970 & 1978, Holm 2014, Wilson and Carril 2016). *D. eximia* may be able to use worker bumblebees since it blooms later and longer, but the workers might be less effective due to their smaller size.

Small bees and an assortment of other insects can access the nectar of *Dicentra* flowers without providing pollination services by biting holes through the base of the corolla (Stern 1961, Ernst 1962). Potter wasps such as *Ancistrocerus oviventris* have been identified as primary nectar robbers of *D. eximia* flowers (Irwin et al. 2010). Once the petals have been perforated, additional insects often take advantage of the holes to gain access to the nectar (Holm 2014).

Seed Dispersal and Establishment

A *Dicentra eximia* inflorescence may contain five to many flowers (Stern 2020). An average flowering stalk has 5.1 branches (Bull-Hereñu, and Claßen-Bockhoff 2011), each bearing 1–3 flowers. The capsules are 10–20 seeded (Fernald 1950). *D. eximia* seeds are dark brown to black with slightly rough surfaces and they have pale-colored, irregularly lobed arils that are almost as large as the seeds (Fukuhara 1999, Rhoads and Block 2007, Stern 2020). Illustrations and close-up photographs of *D. eximia* seeds were provided by Fukuhara (1999).

At maturity *Dicentra eximia* capsules split along their seams (Rydberg 1929) and the seeds fall to the ground. *Dicentra* arils (elaiosomes) are highly attractive to ants and the seeds are usually carried off soon after their release (Berg 1969). After feeding on the lipids in the elaiosomes the ants discard the seeds in their nests, refuse piles, or other locations that are generally favorable for germination (Gómez et al. 2005). An experimental study of another ant-dispersed species in the fumitory family, *Corydalis aurea*, found that seeds deposited in locations selected by ants were 90% more likely to germinate and develop than those planted in random locations in the vicinity of ant nests (Hanzawa et al. 1988). No information was found concerning potential mechanisms for long-distance dispersal in *Dicentra eximia*.

Dicentra eximia seeds require a period of moist, cold stratification to break dormancy. They may germinate over a period of several years, but rapidly lose viability if they dry out (Stern 1961, Deno 1993) so the immediate planting of fresh seeds is recommended for gardeners (Leopold 2005). *D. eximia* seeds germinate at temperatures of 15–21^{o}C (Milstein and Milstein

1976). Deno (1993) observed that the cotyledons and radicles emerged 2–4 weeks after the seeds first split open. *D. eximia* proliferates readily from seeds that are dispersed by ants in both natural and horticultural settings (Leopold 2005, NCCE 2024). Although Wild Bleeding-heart does not spread rapidly by rhizomes the species is reportedly easy to propagate by crown division (Cahalan 2008).

Habitat

Natural populations of *Dicentra eximia* occur in rocky, mountainous areas at elevations from 100–1700 meters above sea level. The plants usually grow in crevices on ledges, outcrops, cliffs, or rocky slopes (Small and Vail 1894, Brooks 1911, Murrill 1916, Stern 1961 & 2020, Riefner and Hill 1983, Rhoads and Block 2007, Tebbitt et al. 2008, Domangue 2012). Hooper (1977) encountered *D. eximia* plants on a limestone ledge during the course of a raven nest site study in Virginia, although Ramsey et al. (1993) noted that the species had established on railroad embankments in the same state. In New Jersey, *D. eximia* was found on acidic, rocky cliff faces and ledges (Edwards 1933, Fairbrothers and Hough 1973).

Dicentra eximia habitat in New Jersey. Images from 2022, courtesy of Charlie Eichelberger, PNHP (left) and the Natural Heritage Programs of Pennsylvania and New Jersey (right).

D. eximia can fare equally well in open or shaded sites (Weakley et al. 2024). Huge colonies were reported in an abandoned field at the summit of a West Virginia mountain and nearby occurrences were also found in open plains dominated by low ericaceous shrubs (Rydberg 1929, Clarkson 1966). Various populations have been associated with Red Spruce (*Picea rubens*) forests (Stephenson and Clovis 1983) or clearings in deciduous woodlands (Domangue 2012). Several occurrences on West Virginia grass or heath balds were situated in transition zones between Red Spruce and hardwood forests (Rentch and Fortney 1997). Cultivated *D. eximia* plants favor acid soils (pH 5.0–6.00), moderate moisture, and shade or partial shade (Milstein and Milstein 1976, Mower and Lee 2003, Eckert et al. 2005, Leopold 2005, Houser 2009).

Wetland Indicator Status

Dicentra eximia 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 2024b)

DIEX

Coefficient of Conservancy (Walz et al. 2020)

CoC = 10. Criteria for a value of 9 to 10: Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance (Faber-Langendoen 2018).

Distribution and Range

Dicentra eximia is native to the eastern United States, where it is endemic to the Appalachian region (POWO 2024, Weakley et al. 2024). Reports of the species outside of that area are likely to be garden escapes or misidentifications (Stern 2020). The map in Figure 1 depicts the extent of *D. eximia* in North America. Some states include both native occurrences and colonies that have established from cultivated plants (eg. Riefner and Hill 1983).

The USDA PLANTS Database (2024b) shows records of *Dicentra eximia* in three New Jersey counties: Bergen, Essex, and Warren (Figure 2). Historic collections from Bergen and Essex counties were cited by Fairbrothers and Hough (1973), and another specimen apparently originated in Middlesex County (Mid-Atlantic Herbaria 2024). Some of the collected plants were probably garden escapes: Snyder (1984) noted that the only unquestionably native population in New Jersey was located in Warren County.

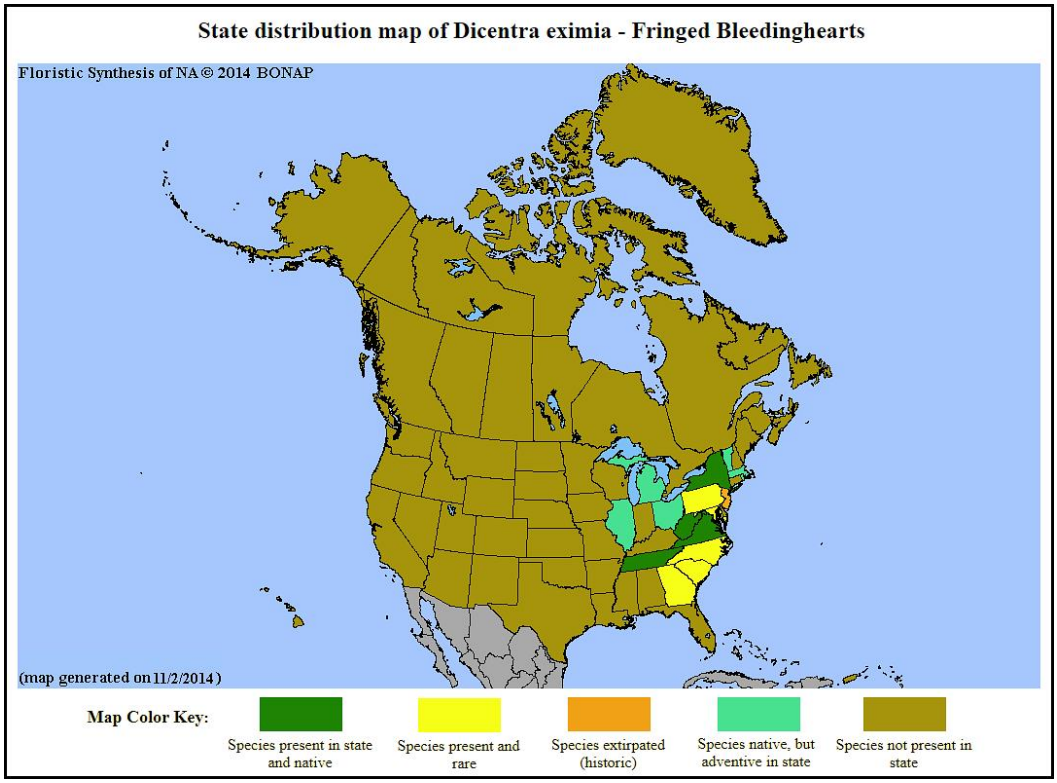


Figure 1. Distribution of D. eximia in North America, adapted from BONAP (Kartesz 2015).

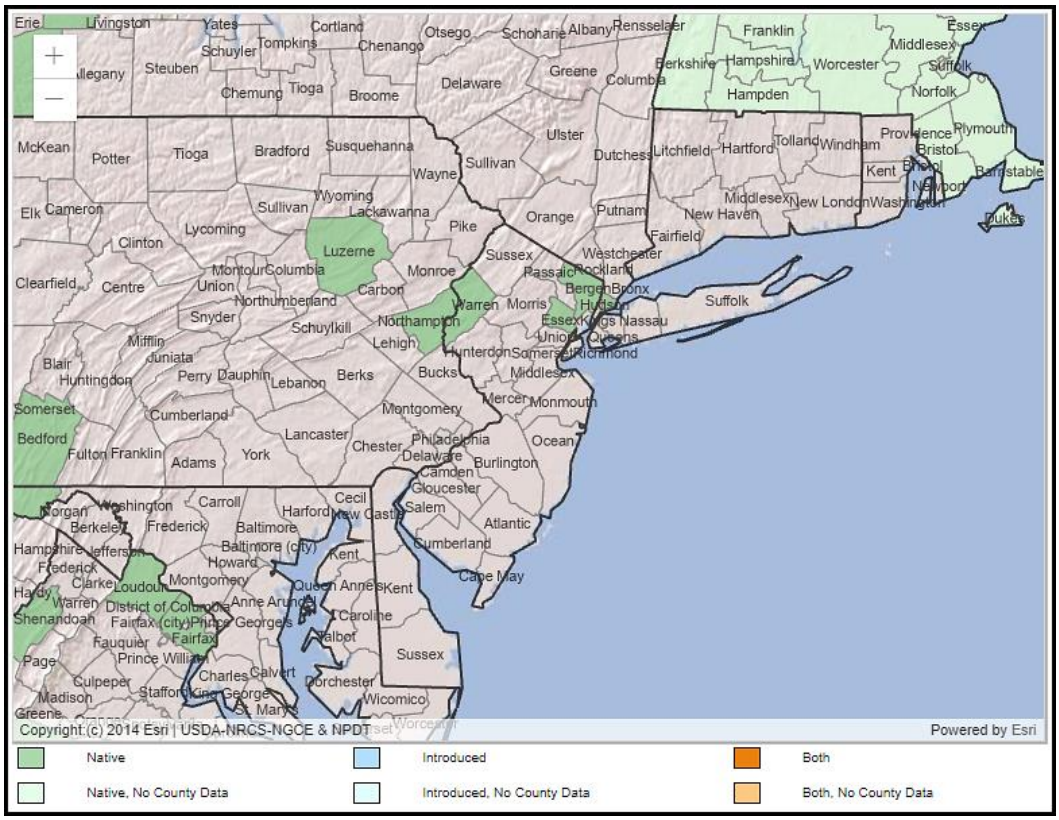


Figure 2. County records of D. eximia in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Dicentra eximia is ranked as apparently secure at a global scale, although the species is due for an updated status review. The G4 rank means the species is at fairly low risk of extinction or collapse due to an extensive range and/or many populations or occurrences but there is some cause for concern as a result of recent local declines, threats, or other factors (NatureServe 2024). The map below (Figure 3) illustrates the conservation status of *D. eximia* throughout its range. Wild Bleeding-heart is critically imperiled (very high risk of extinction) in four states, imperiled (high risk of extinction) in one state, and vulnerable (moderate risk of extinction) in one state. The species is apparently secure in Virginia and West Virginia and has not been ranked in Tennessee. Occurrences outside of those states are generally not accepted as native. Although the map shows *D. eximia* as unranked in Massachusetts, Bertin (2000) characterized it as introduced but persistent in one county and specimens originating from other counties in that state were obtained from sites where it had been cultivated (Mid-Atlantic Herbaria 2024).

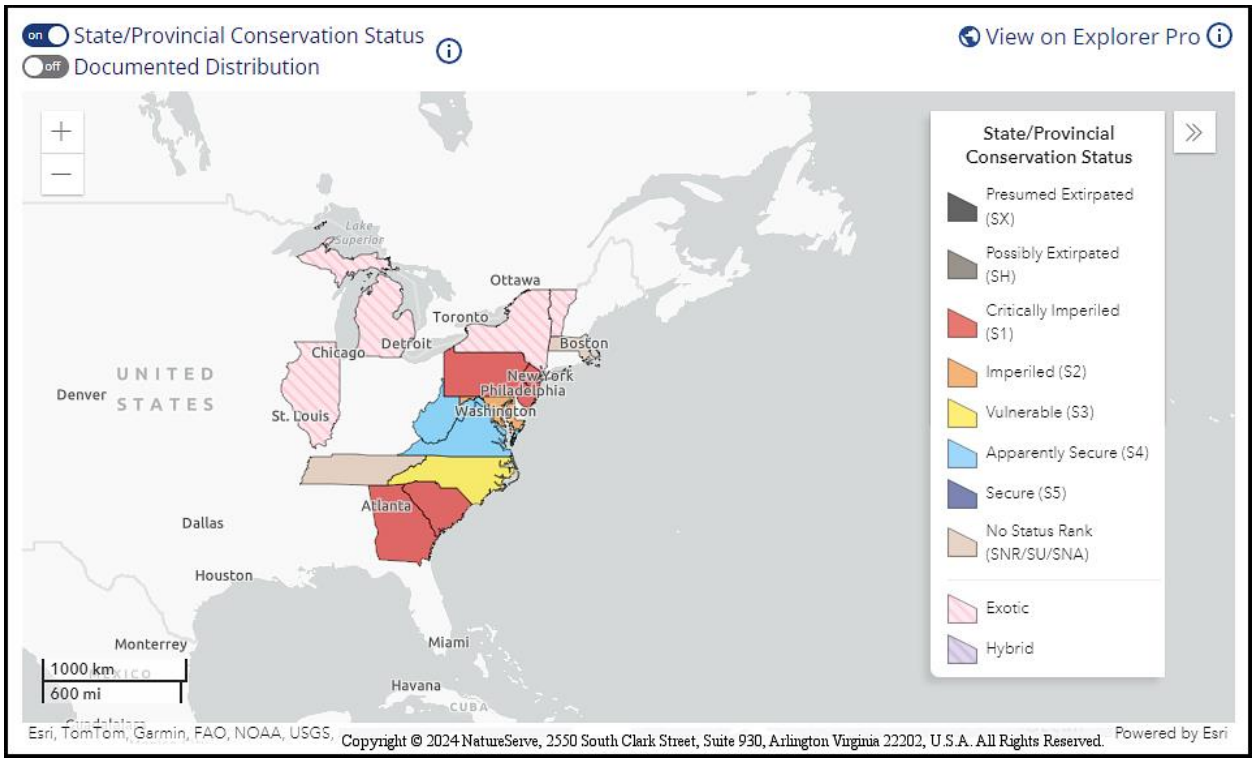


Figure 3. Conservation status of D. eximia in North America (NatureServe 2024).

Dicentra eximia is ranked S1.1 in New Jersey (NJNHP 2024), 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. *D. eximia* 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 Wild Bleeding-heart 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).

Dicentra eximia was first documented in New Jersey by James L. Edwards (1933), although Edwards suspected that his discovery confirmed an earlier report of the species in the state by C. F. Austin. Edwards and two of his colleagues initially found only withered leaves and stalks during January 1933 but their tentative identification was confirmed by a return to the site that June. Vincent Abraitys relocated the population thirty years later with the aid of a spotting scope (Snyder 1984, 1993) but it remained the only known occurrence in the state when the species was listed as endangered by Fairbrothers and Hough (1973). *D. eximia* was not seen in New Jersey for several decades, and it was eventually ranked as a historical species in the state (NJONLM 1992). Over the years, David Snyder made multiple attempts to determine whether the population was still extant, characterizing his efforts as "inconclusive and harrowing" due to the treacherous nature of the habitat, but he remained confident that *D. eximia* was still present in the state and he was proven to be correct when the original population was rediscovered in 2022 (Snyder 1993, NJNHP 2024).

Threats

Few of the threats that are typically identified for upland plant species have been noted as concerns for *Dicentra eximia*. Populations of Wild Bleeding-heart can often persist in decades at sites where they have become established (Robison 1960, NJNHP 2024). The cliff and ledge communities utilized by the species are not well-suited for development or resource extraction, reducing the likelihood of habitat loss from human activities. *D. eximia* appears to be somewhat tolerant of pollution—In Pennsylvania it has been known to grow on old zinc smelting sites, sequestering the metal in its foliage. Although lower photosynthetic rates were found in plants containing zinc no toxic effects were observed (Orlowski 2019). *Dicentra eximia* is also widely reported to be resistant to mammalian herbivory (Tebbitt et al. 2008, Hillock et al. 2015, NJAES 2016, Longfellows 2024, New Moon Nurseries 2024).

Due to the species' popularity in the horticultural community, some populations of *Dicentra eximia* could be vulnerable to collection. Although *D. eximia* is not native to Vermont, Eaton (1946) observed that a single bleeding-heart plant had managed to establish in the wild there, only to be dug up by someone who wished to grow it in their garden. Removal of seeds or plants from the wild continues to be a threat to the species (NatureServe 2024).

The steep decreases in bumblebees that have been documented during the past two decades (Colla et al. 2008, Cameron et al. 2011, Jacobson et al. 2018) signal an emerging threat to *Dicentra eximia*. *D. eximia* cannot produce viable seeds without the assistance of pollinators and bumblebees are one of the few (or only) kinds of insects that can successfully cross-fertilize the plants. Declines in Wild Bleeding-heart populations are likely to result.

Two invasive plant species, *Microstegium vimineum* and *Persicaria perfoliata*, were found growing at the site of New Jersey's *Dicentra eximia* occurrence and their presence was identified as a potential threat to the bleeding-heart (NJNHP 2024). Both of the introduced species produce copious amounts of seed and they are likely to compete with *D. eximia* for the small number of microsites which are suitable for establishment.

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Dicentra eximia* population to climate change. The species was assigned a rank from NatureServe's Climate Change Vulnerability Index using the associated tool (Version 3.02) to estimate its exposure, sensitivity, and adaptive capacity to changing climactic conditions in accordance with the guidelines described by Young et al. (2016) and the state climactic computations by Ring et al. (2013). Based on available data *D. eximia* was assessed as Moderately Vulnerable, meaning that it is expected to show some decrease in abundance or range extent in New Jersey by 2050. According to Frances (2017), a similar conclusion was reached following an assessment in Pennsylvania.

In New Jersey, the impacts of climate change include both elevated temperatures and longer, more frequent summer droughts (Hill et al. 2020). Extended droughts are likely to take a toll on *Dicentra eximia* populations. As discussed earlier, the seeds of Wild Bleeding-heart lose viability as they dry. A study by Vanco (2015) found that *D. eximia* plants growing in full sun could experience tissue damage or even death during hot weather, particularly when the substrate was shallow, suggesting that the species' sensitivity to desiccation persists throughout all life stages. *D. eximia* plants are reportedly able to endure brief periods of drying but they cannot tolerate lengthy summer droughts (New Moon Nurseries 2024).

Bellmare and Moeller (2014) cited *Dicentra eximia* as an example of a species with a small natural distribution that had demonstrated the ability to establish in locations well north of its natural range. Lower winter temperatures would probably not be an obstacle to the species' northward movement if conditions at existing sites become unsuitable. However, the possibility of *D. eximia* shifting its range northward could be inhibited by an inability to disperse propagules over long distances.

The potential for *Dicentra eximia* to persist at existing sites and to colonize new locations will likely be further limited by a reduction in available pollinators. Bumblebee decline is predicted to be exacerbated by climate change (Soroye et al. 2020), and recent research on *Bombus terrestris* by Guiraud et al. (2021) demonstrated that worker bees which developed at higher temperatures were significantly smaller in size. Rising summer temperatures could result in fewer bees with the size and strength to pollinate *Dicentra* flowers.

Management Summary and Recommendations

More detailed data regarding the pollinators of *Dicentra eximia* is urgently required in order to develop meaningful plans for the conservation of native populations. Information needed includes pollinator species identification, the relative contribution of different castes (queens workers, males) to fertilization, and the minimum size or weight of effective pollinators. It is also important to understand how *D. eximia* seeds have been transported over long distances to reach some of the remote locations that are inhabited by the plants.

Assisted colonization may be an appropriate management strategy for species like *Dicentra eximia* that face long-distance dispersal limitations (Bellmare and Moeller 2014). There is already a great deal of information available regarding the propagation of *D. eximia*. However, care must be taken to assure that any source material used to restore the species in the wild originates from genuine native populations, particularly since horticultural variants and hybrids have become so widely established within its range.

Synonyms

The accepted botanical name of the species is *Dicentra eximia* (Ker Gawl.) Torr. Orthographic variants, synonyms, and common names are listed below (ITIS 2024, POWO 2024, USDA NRCS 2024b).

Botanical Synonyms	Common Names
Bicuculla eximia (Ker Gawl.) Millsp.	Wild Bleeding-heart
Bikukulla eximia (Ker Gawl.) Druce	Fringed Bleedinghearts
Capnorchis eximia (Ker Gawl.) Planch.	Turkey Corn
Corydalis eximia (Ker Gawl.) Link	
Diclytra eximia (Ker Gawl.) DC.	
Dielytra eximia (Ker Gawl.) G. Don	
Eucapnos eximius (Ker Gawl.) Bernh.	
Fumaria eximia Ker Gawl.	

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