Veratrum virginicum

Virginia Bunchflower

Liliaceae

Veratrum virginicum by M. C. Barnhart, 2022

***Veratrum virginicum* 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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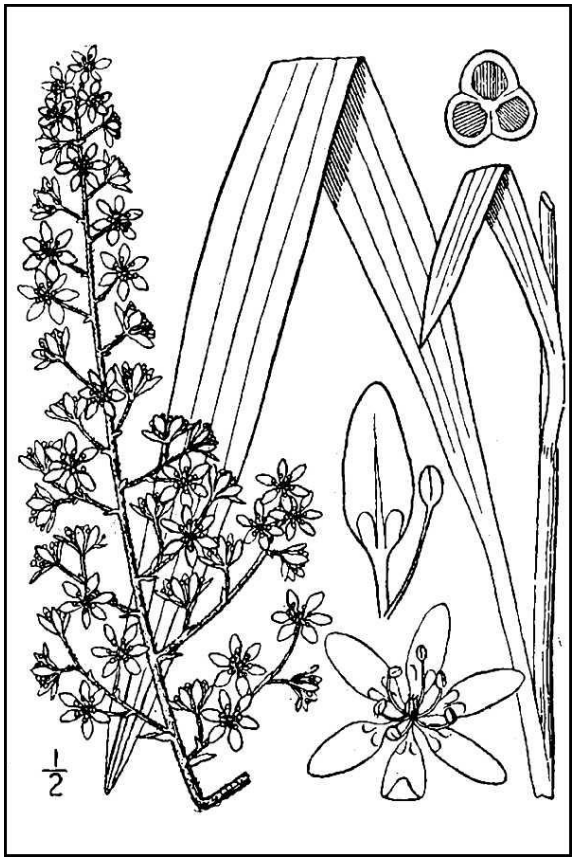
Life History

Veratrum virginicum (Virginia Bunchflower) is a perennial herb traditionally placed in the Liliaceae, or in the Melanthiaceae by authors who further divide the lily family (Kartesz 2015). The synonym *Melanthium virginicum* is still frequently used for the species (e.g. Bodkin and Utech 2020). Despite the lack of clarity regarding its taxonomic position, the Virginia Bunchflower is distinct. Plants have a cluster of basal leaves as well as a few alternate stem leaves, all of which are linear in shape. The base of the stem is bulblike, often retaining thin brown fibers from the bases of older leaves. The branching inflorescence is on a stout, pubescent stem that typically reaches 0.7–1.5 meters in height. The flowers have six smooth-margined tepals (undifferentiated petals and sepals) that bear a pair of glandular spots, and the tepals narrow so abruptly at the base they appear to be stalked. The tepals are initially a creamy white color, but as the flowers age they may turn green, purple, or brown. (See Britton and Brown 1913, Fernald 1950, Godfrey and Wooten 1981, Gleason and Cronquist 1991, Weakley 2015, Bodkin and Utech 2020). *Veratrum hybridum* (aka *Melanthium latifolium*) also has 'stalked' tepals with glandular spots but the outer ends of its tepals are rounded and very wavy, its basal leaves are wider, and it usually grows in drier places (Keller and Brown 1905, Rhoads and Block 2007, Weakley 2015, Bodkin and Utech 2020).



Left: Britton and Brown 1913, courtesy USDA NRCS 2022a. Right: Zirick, 2020.

Below its narrow bulb, *Veratrum virginicum* has a short, thick, erect rhizome with roots arising at the junction (Bodkin 1978). The fibrous roots are relatively shallow, segmented, and

sometimes branching (Hilty 2020, Bodkin 1978). *V. virginicum* is apparently able to reproduce vegetatively, although the mechanism is not completely clear. Moorehouse et al. (2002) indicated that some mature plants have multiple shoots, each capable of producing an inflorescence. Bodkin (1978) thought it possible that buds were produced on underground rootstocks but did not directly observe any buds. Hilty (2020) mentioned that clonal offsets in *Veratrum virginicum* develop from the rhizomes. *V. lobelianum* reproduces vegetatively by producing buds on its rhizome (Stachurska-Swakoń et al. 2018) while *V. woodii* can initiate clones via the forking or splitting of its rhizome (Zomlefer et al. 2018). One method recommended for vegetative propagation of Virginia Bunchflower was planting root cuttings that were 6 mm long and had a bud (PFAF 2022).

Short, fleshy scales form on the inner portion of the bulb during late summer and early fall, elongating into aerial leaves the following growing season (Bodkin 1978). Flowering may occur from June through August and fruits may be produced from August through October (Hough 1983, Weakley 2015). The individual flowers remain open for 9–11 days before changing color, and the total blooming period lasts for about three weeks (Weiherer et al. 2020). Fruits may remain on the stalks as late as January (Les 2020). Flowering can be low in some populations, and a five-year study at one site in Virginia reported an average blooming rate of 17% (Bodkin 1978). Morris (1997) observed a small Mississippi population in which just under half of the plants had flowered. Three consecutive years of monitoring a dozen *V. virginicum* populations in Illinois revealed that blooming rates fluctuated wildly, with flowers being abundant in some years and almost nonexistent during others (Moorehouse et al. 2002).

When grown from seed, *Veratrum virginicum* plants develop slowly. Seedlings produce a single leaf during their first year, then form a bulb before winter (Jackson 2019, PFAF 2022). Several years of growth are needed before a plant is able to flower, sometimes as many as ten (Hilty 2020, PFAF 2022). Plants in the genus *Veratrum* are likely to be long-lived (Zomlefer 1997).

Will McFarland, 2018.

Alan Weakley, 2020.

Cassi Saari, 2013.

Pollinator Dynamics

Bodkin (1978) observed that *Veratrum virginicum* had a number of characteristics attractive to insects including numerous flowers, bright tepals, and large nectar glands. In fresh flowers, the

contrast between the pale tepals and the bright yellow glands may function as a nectar guide (Weiherer et al. 2020). *V. virginicum* flowers also produce an odor that may have a role in pollinator attraction. The scent has been variously described as reminiscent of urine, wet horses, or cow dung, but Weiherer et al. (2020) thought it suggested a combination of raw liver and latex.

Detailed observations of possible pollinators were made by Robertson (1896), who said that *V. virginicum* had a "very peculiar assemblage of visitors" consisting primarily of flies and beetles. Many of the flies observed by Robertson were in the Syrphidae (*Sphaerophoria contiqua, Syritta pipiens*, *Toxomerus marginatus*) and the Tachinidae (*Archytas aterrimus*, *Chetogena claripennis, Gymnoclytia immaculata*. *G. occidua, Linnaemyia comta*, *Paradidyma singularis, Trichopoda pennipes*). In addition to their potential role in pollination, flies in those families are natural enemies of herbivorous arthropods and may help to defend the plants from predators (Tooker et al. 2006). A number of fly species from other families (Sarcophagidae, Muscidae, and Anthomyidae) were also observed by Robertson (1896), but the most abundant visitor was a beetle (*Trichiotinus piger*). Additional beetles have been identified as potential pollinators of *V. virginicum* including *Centrinites strigicollis, Chauliognathus marginatus, Diabrotica cristata, Lucidota sp., Mordella melaena, Mordella marginata, Mordella sp., Photinus pyralis*, and *Typocerus lunulatus* (Robertson 1896, Bodkin 1978, Graham et al. 2012, Weiherer et al. 2020).

Although only one bee (*Halictus confusus*) and two wasps (*Sphex ichneumonea, Euperilampus triangularis*) were seen by Robertson (1896), bees were the dominant pollinators reported by Weiherer et al. (2020). Species documented on Virginia Bunchflower included *Apis mellifera*, *Bombus auricomus, B. griseocollis, Lasioglossum bruneri, L. callidum, L. nymphaearum*, and *L. versatum*. However, significant differences in effectiveness were noted. While the *Lasioglossum* species were actively nectaring and collecting pollen, the other bees appeared to become sluggish and awkward after consuming nectar. It appeared as though some constituents of the nectar were harmful to the larger, long-tongued species but did not adversely affect the smaller, short-tongued bees (Weiherer et al. 2020).

The beetles observed on bunchflowers by Bodkin (1978) did not appear to have much pollen on their bodies, and the author speculated that *V. virginicum* might achieve self-fertilization via the incurving of older stamens toward the floral stigmas. The possibility of self-pollination in the species was further examined by Weiherer et al. (2020). Mechanical self-fertilization was ruled out because the anthers released their pollen before stigmas on the same flower became receptive. It was instead suggested that the bending of anthers facilitated cross-pollination by forming a perch for small pollinators that brought them closer to the stigmas. Experiments showed significantly higher rates of fruit set in open-pollinated flowers than in those from which insects had been excluded. However, Weiherer et al. also noted that the beetles carrying the most pollen did not move between plants much—instead remaining on the same inflorescence for hours—and the researchers postulated that the insects might be facilitating self-fertilization.

Weiherer et al. (2020) counted the number of ovules in 15 randomly selected *V. virginicum* flowers, finding a mean of 57.1 ovules per ovary. Using that as a measure of potential fertility, they were puzzled by the limited seed set observed during their study. In the fertilization experiment, exposed flowers produced an average of 3.4 seeds per fruit whereas bagged flowers

produced 1.2 seeds per fruit. Although Bodkin (1978) reported the production of 'numerous seeds' in the genus, many other authors have indicated that *Veratrum virginicum* fruits usually have several seeds in each of their three carpels and that the typical number per capsule is 8–10 (Britton and Brown 1913, Fernald 1950, Godfrey and Wooten 1981, Gleason and Cronquist 1991). Hilty (2020) cited a slightly higher rate of 12 or more seeds per capsule. In comparison to those reported rates, the seed set obtained by Weiherer et al. was still low (~25–30%), but not as low as the 6% they calculated based on the number of ovules per ovary. The question that remains is why a flower with around 57 ovules normally produces only about 10 seeds.

Potential seed production may also be more limited than appearances would suggest because not all of the flowers in an inflorescence are capable of developing seeds. Most *V. virginicum* flowers are perfect, but some flowers on the secondary branches of an inflorescence can be staminate (Bodkin 1978). Usually the terminal flowers on the branches, which are the last to bloom, lack pistils. The strategy could help plants to conserve resources if the primary function of late-blooming flowers on an inflorescence is to fertilize older receptive flowers, or if resources are limited then less energy would be spent shuttling nutrients to the flowers furthest from the main stem (Weiherer et al. 2020).

Seed Dispersal

Mature capsules of *Veratrum virginicum* usually remain erect on the stalks after dehiscence but they have also been reported to dangle (Gordon and Arsenault 2016). The seeds are pale yellow to tan and broadly winged (Genesis Nursery 2015), measuring 5–8 mm in length and 2.5–4 mm in width including the wings (Bodkin and Utech 2020). Although details about seed dispersal in *V. virginicum* were not found, wings on seeds are usually indicative of wind-dispersal (Howe and Smallwood 1982). Dispersal by wind has been observed in *Veratrum lobelianum* and *V. woodii*, two related species that also have winged seeds (Stachurska-Swakoń et al. 2018, Zomlefer et al. 2018).

The seeds of *Veratrum* species usually require a period of winter dormancy (Zomlefer et al. 2018). Propagators of *V. virginicum* suggest either fall planting or a 2–3 month interval of cold stratification, and the importance of maintaining the seeds in a moist environment has been emphasized (Genesis Nursery 2015, Jackson 2019, PFAF 2022). Jackson (2019) reported close to 95% germination when following the recommended stratification technique, but PFAF (2022) advised that germination can be slow or erratic and Bodkin (1978) had no success when attempting to establish the plants from seed. The length of seed viability is unknown for Virginia Bunchflower. Although Eggert (1879) observed the bunchflower's rapid colonization of a recently formed gap it was not clear whether those *V. virginicum* plants originated from a seed bank or freshly introduced propagules. Hesse et al. (2006) found that the seeds of a related but weedy European species (*Veratrum album*) formed a short-term seed bank with most germination occurring in the second year, but the authors predicted a low likelihood of recolonization when mature plants were no longer present at a site. No studies were found regarding the establishment of *Veratrum virginicum* from seed in natural settings.

Habitat

Veratrum virginicum grows in forested or open wetlands at elevations of 10–800 meters. Characteristic communities have been described as swamps, wet forests, moist woods, damp clearings, savannas, marshes, bogs, fens, prairies, and meadows (Aldrich et al. 1986, Morris 1997, Moorehouse et al. 2002, Rhoads and Block 2007, Weakley 2015, Gordon and Arsenault 2016, Bodkin and Utech 2020, NJNHP 2022). The wetlands where *V. virginicum* occurs are often spring-fed or seepage areas (Bodkin 1978, Rhoads and Block 2007, Weakley 2015), but streamside occurrences have been reported (Moorehouse et al. 2002) and the species has also been found in tidal swamps in Maryland (Tiner 2009). A study of soil preferences by Wherry (1927) showed *M. virginicum* as growing well in medi-acid (pH 4.1-5.0) or minim-acid (pH 6.1-6.0) soils but growing best in sub-acid (pH 5.1-6.0) soils.

In the Midwest, some populations occur in gaps associated with railroad corridors (Eggert 1879, Aldrich et al. 1986, Hilty 2020), and Jackson (2019) discovered a small population in a roadside ditch near a tallgrass prairie restoration site. Open habitats may be favorable for establishment and/or growth of *V. virginicum*. Eggert (1879) observed that the species disappeared from one site after the habitat became brushy, and reappeared with profusion at another site following a fire that removed the understory. It is not clear whether Virginia Bunchflower forms fungal associations, but arbuscular mycorrhizae have been reported in *Veratrum viride* (Wang and Qiu 2006).

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). *Veratrum virginicum* has more than one wetland indicator status within the state. In the Atlantic Coastal Plain region, Virginia Bunchflower is an obligate wetland species, meaning that it almost always occurs in wetlands. In the rest of the state it is a facultative wetland species, meaning that it usually occurs in wetlands but may occur in nonwetlands (U. S. Army Corps of Engineers 2020).

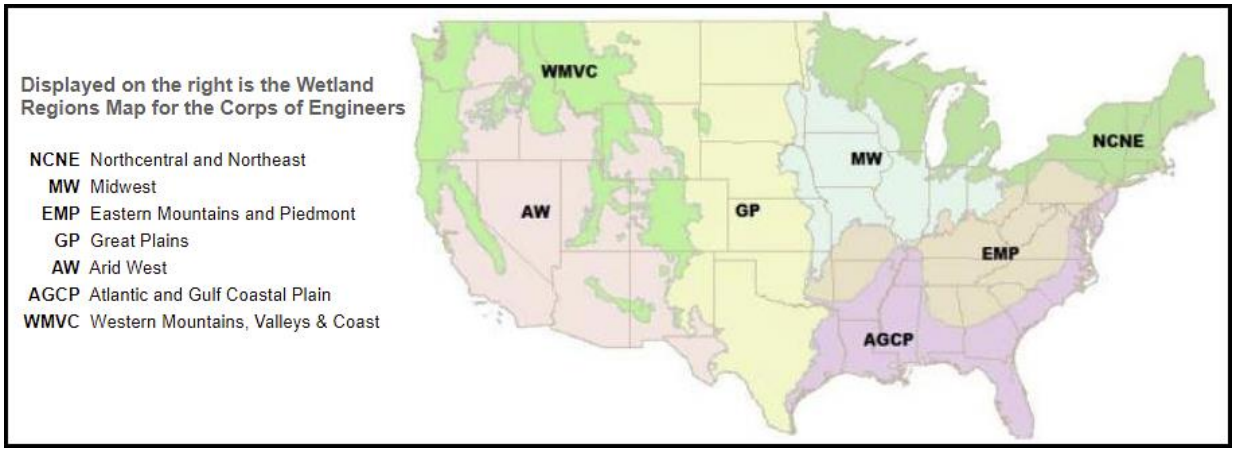


Figure 1. Mainland U. S. wetland regions, adapted from U. S. Army Corps of Engineers (2020).

USDA Plants Code (USDA, NRCS 2022b)

VEVI5

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 *Veratrum virginicum* is limited to the central and eastern United States (POWO 2022). The map in Figure 2 depicts the extent of *V. virginicum* in North America.

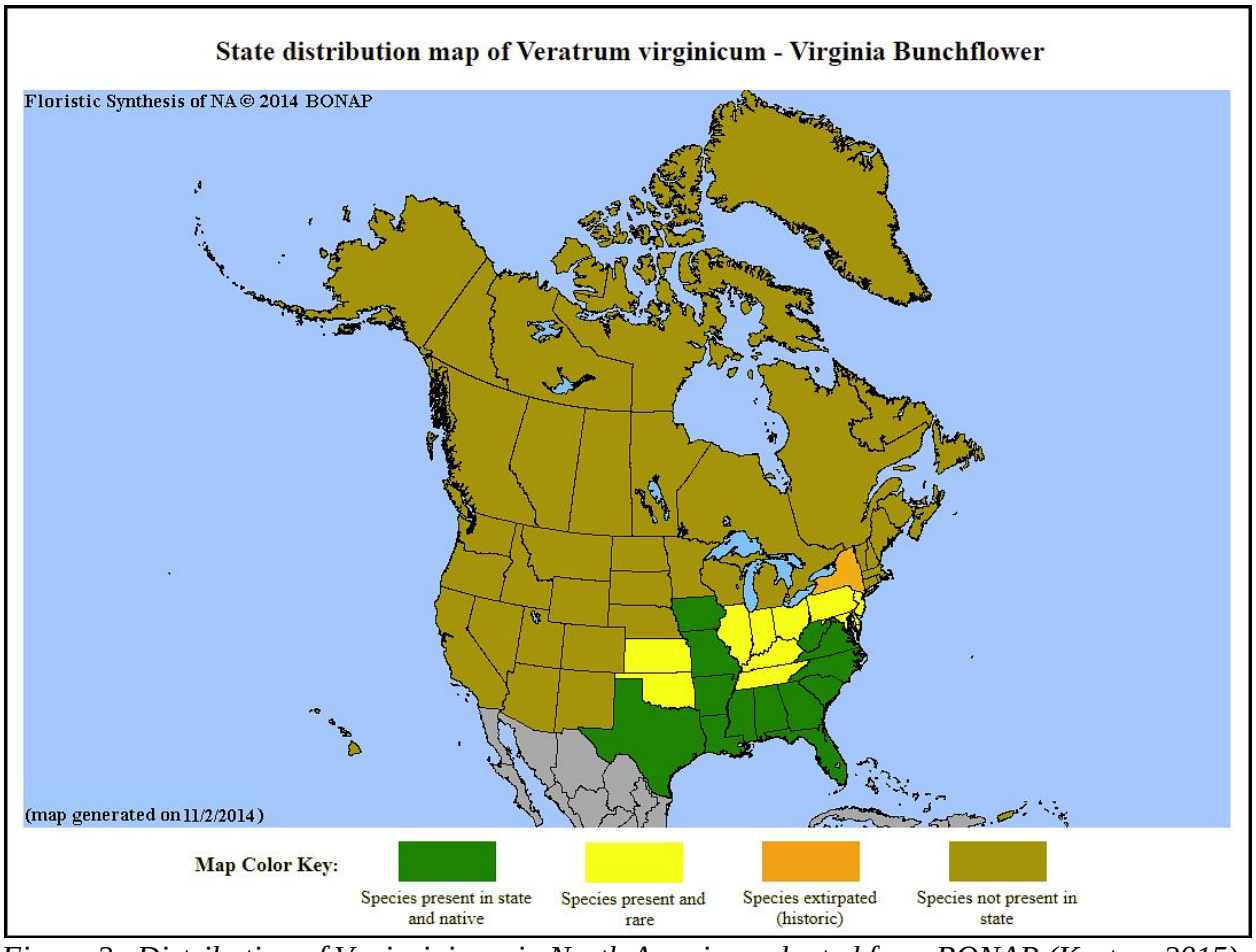


Figure 2. Distribution of V. virginicum in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2022b) shows records of *Veratrum virginicum* in 15 New Jersey counties: Bergen, Burlington, Camden, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, and Union (Figure 3 below). Some herbarium

specimens also list sites of collection in Essex and Warren Counties (Mid-Atlantic Herbaria 2022). The data include historic observations and do not reflect the current distribution of the species.

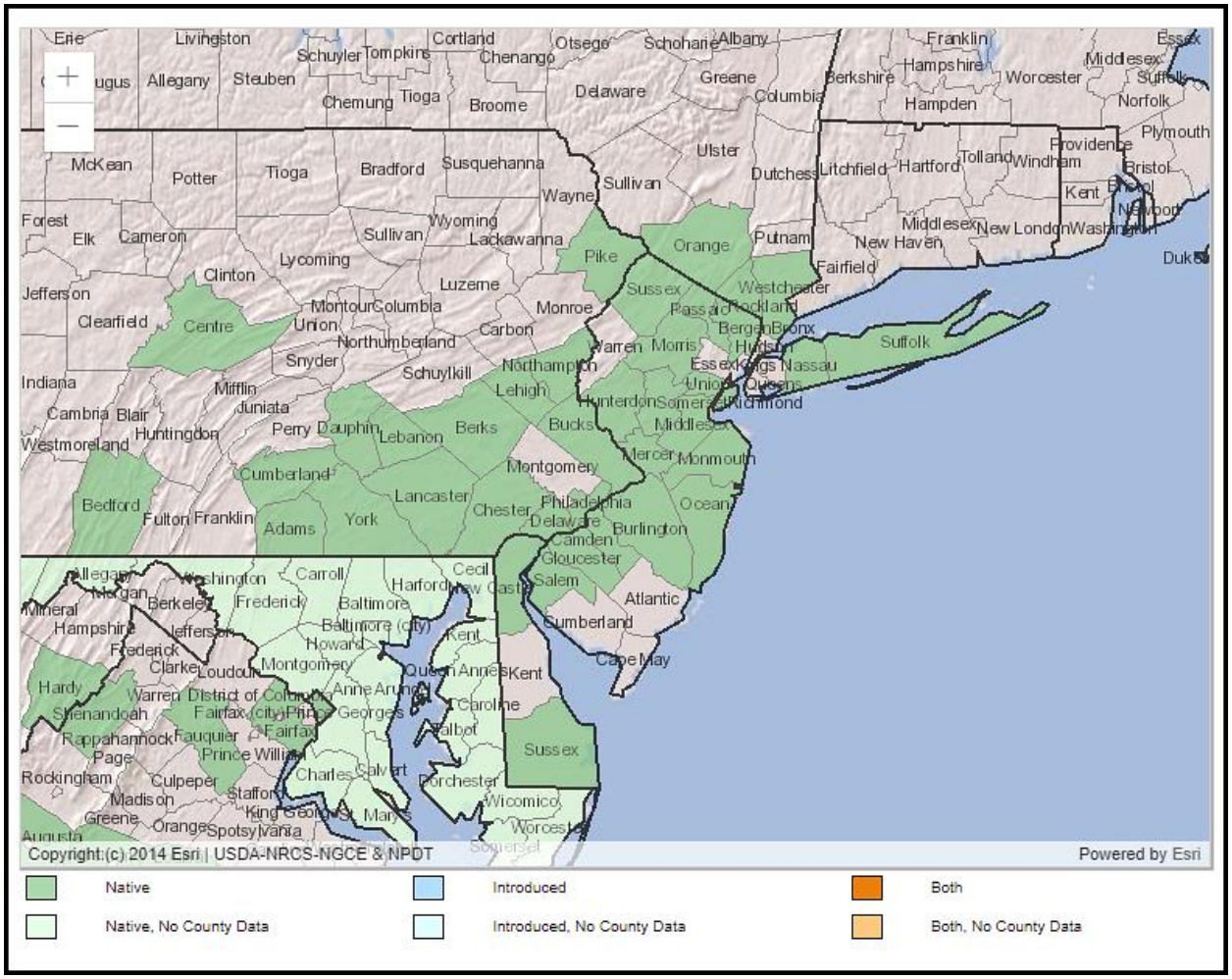


Figure 3. County records of V. virginicum in New Jersey and vicinity (USDA NRCS 2022b).

Conservation Status

Veratrum virginicum 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 4) illustrates the conservation status of *V. virginicum* throughout its range. Virginia Bunchflower is critically imperiled (very high risk of extinction) in six states, imperiled (high risk of extinction) in seven states, vulnerable (moderate risk of extinction) in two states, and possibly extirpated in New York and West Virginia. The species is shown as apparently secure in two states and is unranked in seven others.

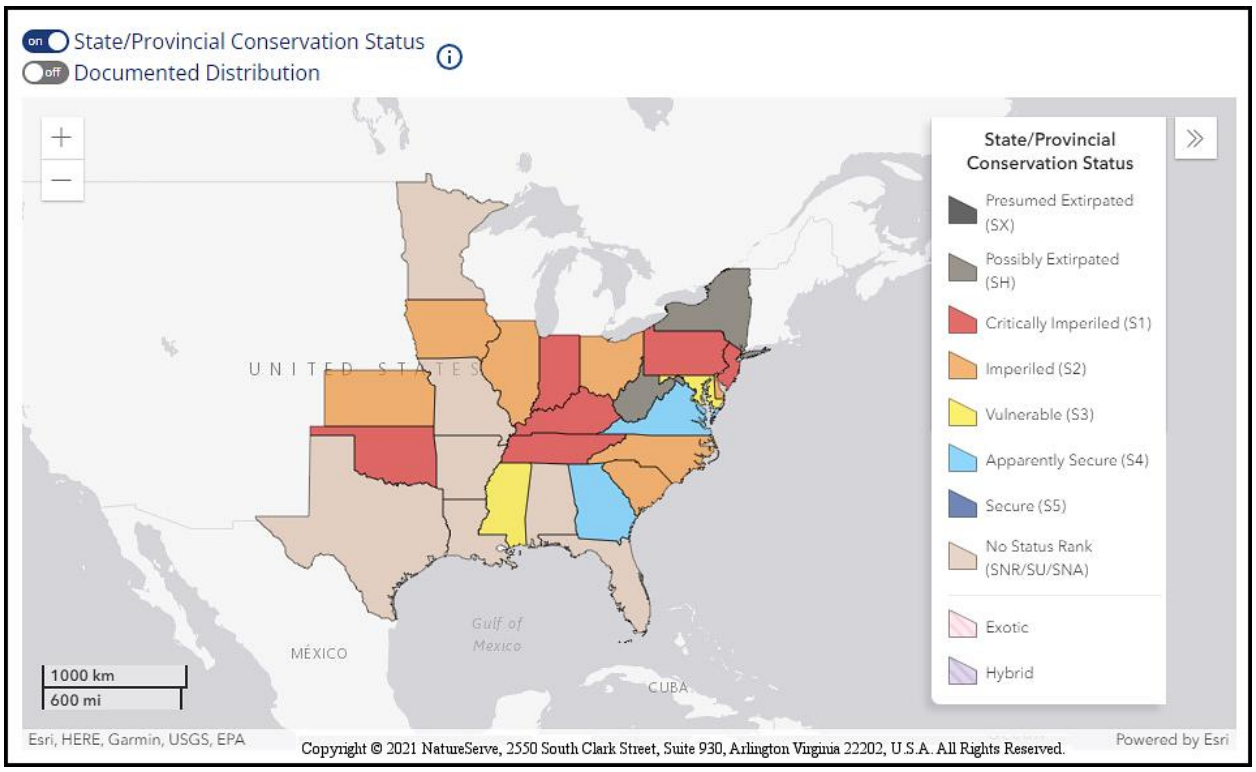


Figure 4. Conservation status of V. virginicum in North America (NatureServe 2022).

New Jersey is one of the states where *Veratrum virginicum* 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. *V. virginicum* 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 such as wetlands or coastal habitats, being listed does not currently provide broad statewide protection for the plants. Additional regional status codes assigned to Virginia Bunchflower 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).

Veratrum virginicum was once considerably more plentiful in New Jersey than it is today. Although the species was noted as somewhat rare in an early state flora (Willis 1874), Britton (1881) cited it as present in Bergen, Camden, Essex, Monmouth, Morris and Union counties, adding that it could also be found in 'the southern counties'. Records from Burlington, Gloucester, and Ocean counties were later specified by Britton (1889), although Keller and Brown (1905) indicated that one of the Gloucester County sites had already been destroyed. Virginia Bunchflower was generally reported to be more abundant in the northern and central parts of the state than in the southern region (Britton 1889, Taylor 1915, Stone 1911). By the end of the 20th century, *V. virginicum* had been extirpated from all but two of the counties where it formerly occurred (Breden et al. 2006), but a third county was ascertained to host an extant population following the discovery of a small colony in 2005 (NJNHP 2022). Of the 27

occurrences tracked by the state's Natural Heritage Program only five are still believed to be extant.

Threats

No overarching threats to *Veratrum virginicum* are apparent, although the species is imperiled in 65 % of states where it has been recorded and is presently known to be extant in less than 20% of the places where it once occurred in New Jersey. In general, the decline of Virginia Bunchflower is probably attributable to wetland losses resulting from intense regional development and urbanization (Ehrenfeld 2000, NJDSR 2021). Although wetlands now enjoy a certain amount of protection, *V. virginicum* habitat may still be indirectly affected by activities on adjacent lands or directly disturbed by the development of utility right-of-ways. Habitat destruction has been cited as the reason for the loss of several Illinois populations (Hilty 2020).

Natural processes that alter community characteristics can also threaten *V. virginicum*. Two New Jersey populations declined or were destroyed after beavers (*Castor canadensis*) flooded their habitats (Snyder 2000). Observations that Virginia Bunchflower was more plentiful at open sites (Eggert 1879) indicate that the species might also be threatened by successional processes or competition. At one New Jersey location it was observed that the *V. virginicum* plants were confined to the more open areas of a dense thicket (NJNHP 2022). Zomlefer et al. (2018) suggested that understory light availability may govern flowering in *V. woodii*.

The proliferation of non-native plants has probably contributed to the demise of some populations. Dolan et al. (2011) studied the flora of one Indiana county where *V. virginicum* had historically occurred and found that while the total number of species was comparable to pre-1940 records, a larger proportion of the recent flora was non-native and the species that had been lost were disproportionately high-quality wetland plants. Specific threats to extant New Jersey populations of *V. virginicum* have been identified from the highly invasive *Phragmites australis* ssp. *australis* and also from another non-native grass that was planted to stabilize a utility right-of-way that cut through the occurrence (NJNHP 2022).

Plants in the genus *Veratrum* are poisonous (Gleason and Cronquist 1991) and all parts of *V. virginicum* are highly toxic (PFAF 2022). Although Hilty (2020) indicated that the toxic compounds tend to protect the plants from mammalian herbivores, some impacts from White-tailed Deer (*Odocoileus virginianus*) have been documented for Virginia Bunchflower (Miller et al. 1992). Predispersal seed predation by Geometrid moth larvae was observed in *Veratrum lobelianum*, which also contains high concentrations of toxic alkaloids, but the levels of toxicity in the plants were found to fluctuate seasonally (Stachurska-Swakoń et al. 2018).

Extracts from *Veratrum virginicum* seeds have been tested for antimicrobial activity against four microorganisms, and results of laboratory experimentation showed that the species produced a relatively large inhibition zone (19 mm) against *Candida albicans* (Borchardt et al. 2008). While the study was focused on medical applications, the results raise the possibility that *V. virginicum* seeds could have some natural protection against certain types of pathogens.

An assessment of rare flora in Illinois, where *V. virginicum* is listed as imperiled, concluded that the species is moderately vulnerable to climate change (Molano-Flores et al. 2019). The rank signifies that the bunchflower's abundance or range in Illinois is likely to decrease by 2050. Climate change impacts forecast for New Jersey include an increase in extreme events that may include both floods and droughts (Hill et al. 2020), so the effects on *V. virginicum* in the state are likely to be site-specific and difficult to predict.

Management Summary and Recommendations

Research should be one of the top management priorities for *Veratrum virginicum*, as many critical aspects of the species' life history remain unstudied. Clarity is needed on the plant's mechanism for vegetative reproduction and, more importantly, on the relative importance of sexual and asexual reproduction in the maintenance of established populations. Valuable information was revealed in one of the few recent studies that focused on *V. virginicum* (Weiherer et al. 2020), but the research also raised additional questions as to why numerous ovules often result in only a limited number of seeds and how much of insect-mediated pollination enables cross-fertilization vs. self-fertilization. Other subject areas that require further investigation include typical seed dispersal distances, possible mechanisms for long-distance dispersal, seed longevity and the potential for seedbanking, germination and establishment requirements in natural settings, critical light levels for growth and reproduction, and the impacts of competition with native and non-native plant species.

Until more information is available to aid in conservation planning for the species, extant populations of Virginia Bunchflower should be monitored on a regular basis. In addition to ascertaining whether known occurrences are still present and appear to be viable, site visits can provide insight regarding different environmental conditions that may be beneficial or harmful to the plants. Monitoring visits can also be used to identify existing and potential threats, and up-to-date information regarding the current statewide status of the species can help to inform decisions regarding the application of resources for the preservation of remaining populations.

Synonyms

The accepted botanical name of the species is *Veratrum virginicum* (L.) W. T. Aiton. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA NRCS 2022b, POWO 2022). The former genus name *Melanthium* means 'black flower' and probably refers to the way the tepals change color in age (Britton and Brown 1913).

Botanical Synonyms	**Common Names**
Melanthium virginicum L.	Virginia Bunchflower
Evonyxis monoica Raf.	Bunchflower Lily
Evonyxis undulata Raf.	Bog Bunchflower
Evonyxis virginica (L.) Raf.	
Helonias virginica (L.) Sims	

Leimanthium monoicum (Walter) Sweet
Leimanthium virginicum (L.) Willd.
Melanthium biglandulosum Bertol.
Melanthium dispersum Small
Melanthium hybridum Elliott
Melanthium laetum Kunth
Melanthium monoicum Pursh
Melanthium monoicum Walter
Melanthium polygamum Desr.
Zigadenus hybridus Endl. ex Kunth
Zigadenus monoecus (Walter) Kunth
Zigadenus virginicus Endl. ex Kunth

References

Aldrich, James R., Lee A. Casebere, and Michael A. Homoya. 1986. The discovery of native rare vascular plants in northern Indiana. Indiana Academy of Science 95: 421–428.

Barnhart, M. C. 2022. Cover photo of *Veratrum virginicum* from Missouri. Shared via iNaturalist at https://www.inaturalist.org/observations/123401269, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Bodkin, Norlyn L. 1978. A Revision of North American *Melanthium* L. (Liliaceae). Doctoral dissertation, University of Maryland, College Park, MD. 142 pp.

Bodkin, Norlyn L. and Frederick H. Utech. Page updated November 5, 2020. *Melanthium virginicum* Linnaeus. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed July 6, 2022 at http://floranorthamerica.org/Melanthium_virginicum

Borchardt, Joy R., Donald L. Wyse, Craig C. Sheaffer, Kendra L. Kauppi, R. Gary Fulcher, Nancy J. Ehlke, David D. Biesboer, and Russell F. Bey. 2008. Antioxidant and antimicrobial activity of seed from plants of the Mississippi river basin. Journal of Medicinal Plants Research 2(4): 81–93.

Breden, T. F., J. M. Hartman, M. Anzelone and J. F. Kelly. 2006. Endangered Plant Species Populations in New Jersey: Health and Threats. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, Trenton, NJ. 198 pp.

Britton, N. L. 1881. A preliminary catalogue of the flora of New Jersey. Geological Survey of New Jersey, Office of the Survey, Rutgers College, New Brunswick, NJ. 233 pp.

Britton, N. L. 1889. Catalog of plants found in New Jersey. Geological Survey of New Jersey, Final report of the State Geologist 2: 27–642.

Britton, N. L. and A. Brown. 1913. An Illustrated Flora of the Northern United States and Canada in three volumes: Volume I (Ferns to Buckwheat). Second Edition. Reissued (unabridged and unaltered) in 1970 by Dover Publications, New York, NY. 680 pp.

Dolan, Rebecca W., Marcia E. Moore, and Jessica D. Stephens. 2011. Documenting effects of urbanization on flora using herbarium records. Journal of Ecology 99: 1055–1062.

Eggert, H. 1879. *Melanthium virginicum*. Botanical Gazette 4(12): 241.

Ehrenfeld, Joan G. 2000. Evaluating wetlands within an urban context. Ecological Engineering 15: 253–265.

Faber-Langendoen, D. 2018. Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments. NatureServe, Arlington, VA. 52 pp.

Fernald, M. L. 1950. Gray's Manual of Botany. Dioscorides Press, Portland, OR. 1632 pp.

Genesis Nursery. 2015. Monocotyledons 2. Cultivation tips for some native plants from Genesis Nursery, Tampico, IL. Available at http://www.genesisnurseryinc.com/UP%20UR%20C/C4%20monocots2.junca-xyr.pdf

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Second Edition. The New York Botanical Garden, Bronx, NY. 910 pp.

Godfrey, R. K. and J. W. Wooten. 1981. Aquatic and Wetland Plants of Southeastern United States: Monocotyledons. The University of Georgia Press, Athens, GA. 728 pp.

Gordon, Ted and Joseph Arsenault. 2016. Flora of Burden Hill Forest: A checklist for a Salem County, New Jersey landscape. Bartonia 69: 20–46.

Graham, Elizabeth E., John F. Tooker, and Lawrence M. Hanks. 2012. Floral host plants of adult beetles in central Illinois: An historical perspective. Annals of the Entomological Society of America 105(2): 287–297.

Hesse, Elze, Mark Rees, and Heinz Müller-Schärer. 2006. Seed bank persistence of clonal weeds in contrasting habitats: Implications for control. Plant Ecology 190: 233–243.

Hill, Rebecca, Megan M. Rutkowski, Lori A. Lester, Heather Genievich, and Nicholas A. Procopio (eds.). 2020. New Jersey Scientific Report on Climate Change, Version 1.0. New Jersey Department of Environmental Protection, Trenton, NJ. 184 pp.

Hilty, John. 2020. *Melanthium virginicum*. Illinois Wildflowers. Accessed July 6, 2022 at https://www.illinoiswildflowers.info/prairie/plantx/bunchflower.html

Hough, Mary Y. 1983. New Jersey Wild Plants. Harmony Press, Harmony, NJ. 414 pp.

Howe, Henry F. and Judith Smallwood. 1982. Ecology of seed dispersal. Annual Review of Ecology, Evolution, and Systematics 13: 201–228.

ITIS (Integrated Taxonomic Information System). Accessed November 13, 2021 at http://www.itis.gov

Jackson, Laura. 2019. Irvine Prairie. Tallgrass Prairie Center Newsletter, Summer 2019. University of Northern Iowa, Cedar Falls, IA. Available at https://scholarworks.uni.edu/cgi/viewcontent.cgi?article=1021&context=tpcnews

Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (http://www.bonap.net/tdc). Chapel Hill, NC. [Maps generated from Kartesz, J. T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].

Keller, Ida A. and Stewardson Brown. 1905. Handbook of the Flora of Philadelphia and Vicinity. Philadelphia Botanical Club, Philadelphia, PA. 360 pp.

Les, Donald H. 2020. Aquatic Monocotyledons of North America: Ecology, Life History and Systematics. CRC Press, Boca Raton, FL. 568 pp.

McFarland, Will. 2018. Photo of *Veratrum virginicum* leaves from Mississippi. Shared via iNaturalist https://www.inaturalist.org/observations/15107816, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Mid-Atlantic Herbaria. 2022. https://midatlanticherbaria.org/portal/index.php Accessed on January 13, 2022.

Miller, Scott G., Susan P. Bratton, and John Hadidian. 1992. Impacts of White-tailed Deer on endangered and threatened vascular plants. Natural Areas Journal 12(2): 67–74.

Molano-Flores, Brenda, David N. Zaya, Jill Baty, and Greg Spyreas. 2019. An assessment of the vulnerability of Illinois' rarest plant species to climate change. Castanea 84(2): 115–127.

Moorehouse, Angella, Anne Mankowski, William E. McClain, and John E. Ebinger. 2002. Status of the known populations of the Virginia bunchflower (*Melanthium virginicum*) in Illinois. Castanea 67(2): 188–192.

Morris, Michael Wayne. 1997. Contributions to the flora and ecology of the northern Longleaf Pine belt in Rankin County, Mississippi. SIDA 17(3): 615–626.

NatureServe. 2022. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed July 6, 2022 at https://explorer.natureserve.org/

NJDSR (New Jersey Division of Science and Research). 2021. Endangered Plants. From Environmental Trends: Plants and Wildlife, N. J. Department of Environmental Protection, available at https://www.nj.gov/dep/dsr/trends/

NJNHP (New Jersey Natural Heritage Program). 2010. Special Plants of NJ - Appendix I - Categories & Definitions. Site updated March 22, 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2022. Biotics 5 Database. NatureServe, Arlington, VA. Accessed February 1, 2022.

PFAF (Plants for A Future). 2022. *Melanthium virginicum*. Plant database promoting ecologically sustainable horticulture, available at https://pfaf.org/user/Plant.aspx?LatinName=Melanthium+virginicum

POWO. 2022. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Retrieved July 6, 2022 from http://www.plantsoftheworldonline.org/

Rhoads, Ann Fowler and Timothy A. Block. 2007. The Plants of Pennsylvania. University of Pennsylvania Press, Philadelphia, PA. 1042 pp.

Robertson, Charles. 1896. Flowers and insects. XVI. Botanical Gazette 21(5): 266–274.

Saari, Cassi. 2013. Photo of *Veratrum virginicum* fruits from Illinois. Shared via iNaturalist at https://www.inaturalist.org/observations/378384, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Snyder, David. 2000. One hundred lost plants found. Bartonia 60: 1–22.

Stachurska-Swakoń, Alina, Kinga Kostrakiewicz-Gieralt, and Joanna Świerczek. 2018. Variability of morphological traits of mountain *Veratrum lobelianum* in lowland locality. Ecological Questions 29(2): 61–69.

Stone, Whitmer. 1911. The Plants of Southern New Jersey. Quarterman Publications, Boston, MA. 828 pp.

Taylor, Norman. 1915. Flora of the vicinity of New York - A contribution to plant geography. Memoirs of the New York Botanical Garden 5: 1–683.

Tiner, Ralph W. 2009. Field Guide to Tidal Wetland Plants of the Northeastern United States and Neighboring Canada. University of Massachusetts Press, Amherst, MA. 459 pp.

Tooker, John F., Martin Hauser, and Lawrence M. Hanks. 2006. Floral host plants of Syrphidae and Tachinidae (Diptera) of central Illinois. Annals of the Entomological Society of America 99(1): 96–112.

U. S. Army Corps of Engineers. 2020. National Wetland Plant List, version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html U. S. Army Corps of Engineers Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2022a. *Veratrum virginicum* illustration from Britton, N. L. and A. Brown, 1913, An illustrated flora of the northern United States, Canada and the British Possessions, 3 vols., Kentucky Native Plant Society, New York, Scanned By Omnitek Inc. Image courtesy of The PLANTS Database (http://plants.usda.gov). National Plant Data Team, Greensboro, NC.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2022b. PLANTS profile for *Veratrum virginicum* (Virginia Bunchflower). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed July 6, 2022 at http://plants.usda.gov

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

Wang, B., and Y. L. Qiu. 2006. Phylogenetic distribution and evolution of mycorrhizas in land plants. Mycorrhiza 16(5): 299–363.

Weakley, A. S. 2015. Flora of the southern and mid-Atlantic states, working draft of May 2015. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC.

Weakley, Alan. 2020. Photo of *Veratrum virginicum* from North Carolina. Shared via iNaturalist at https://www.inaturalist.org/observations/55097618, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Weiherer, Daniel, Kayla Eckardt, and Peter Bernhardt. 2020. The floral ecology and breeding system of *Veratrum virginicum* (Melanthiaceae). Journal of the Torrey Botanical Society 147(3): 258–271.

Wherry, Edgar T. 1927. Divergent soil reaction preferences of related plants. Ecology 8(2): 197–206.

Willis, O. 1874. Catalogue of Plants Growing in the State of New Jersey. J. W. Schermerhorn, New York, NY. 92 pp.

Zirick. 2020. Photo of *Veratrum virginicum* from Alabama. Shared via iNaturalist at https://www.inaturalist.org/observations/70830560, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Zomlefer, Wendy B. 1997. The genera of Melanthiaceae in the southeastern United States. Harvard Papers in Botany 2(2): 133–177.

Zomlefer, Wendy B., Jason R. Comer, Rima D. Lucardi, J. L. Hamrick, and James R. Allison. 2018. Distribution and genetic diversity of the rare plant *Veratrum woodii* (Liliales: Melanthiaceae) in Georgia: A preliminary study with AFLP fingerprint data. Systematic Botany 43(4): 858–869.