Uvularia puberula var. nitida

Pine Barren Bellwort

Colchiaceae



Uvularia puberula var. nitida by Jason Hafstad, 2021

Uvularia puberula var. nitida 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

> 501 E. State St. PO Box 420 Trenton, NJ 08625-0420

Prepared by: Jill S. Dodds jsdodds@biostarassociates.com

October, 2024

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

This report should be cited as follows: Dodds, Jill S. 2024. *Uvularia puberula* var. *nitida* 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, Trenton, NJ. 18 pp.

Life History

Uvularia puberula var. *nitida* (Pine Barren Bellwort) is a rhizomatous perennial herb. Over the years *Uvularia* has been placed in an assortment of families including Calochortaceae, Liliaceae, Melanthiaceae, and Uvulariaceae but it is currently included in the Colchiaceae. Morphological and molecular characteristics support the division of *Uvularia* into two sections: *U. puberula* is included in Section *Oakesiella* along with *U. sessilifolia* and *U. floridana* (Wilbur 1963, Hayashi et al. 1998, Boyd and Thalmeyer 2014). Two varieties of *U. puberula* have been described, although they are not universally accepted (see Synonyms and Taxonomy section). All of the *U. puberula* plants in New Jersey are var. *nitida*.



Left: *U. puberula*, Britton and Brown 1913, courtesy USDA NRCS 2024a. <u>Right</u>: *U. puberula* var. *nitida*, Jason Hafstad, 2017.

Uvularia puberula has a short (0.5–1 cm) rhizome with a cluster of fleshy roots. It does not spread clonally but several stems can arise from a single rhizome (Wijesinghe and Whigham 2001). The stems are once-branched, conspicuously angled near the top, and up to 4.5 dm tall. The upper stems of typical *U. puberula* plants are generally pubescent but those of var. *nitida* are often smooth or nearly so. The elliptical leaves are alternate, sessile (or occasionally slightly clasping at the base), and slightly rough along the edges. Dietz (1952) observed that the leaves may appear to be more strongly clasping early in the season before they have completely unfolded. *U. puberula* produces 1–3 flowers per stem on downwardly arching stalks that are

0.5–2 cm long. Each flower has six pale yellow or greenish tepals that are 1–2.5 cm long and 2–4 mm wide, six stamens on short filaments, and a deeply divided style (stigmatic lobes 4–6 mm long). The fruit is a sharply-winged, three-parted capsule that is 1.5–3.7 mm in length and brown at maturity. (See Watson 1879, Britton and Brown 1913, Fernald 1950, Wilbur 1963, Gleason and Cronquist 1991, Hayashi et al. 1998, Utech and Kawano 2020).

U. puberula var. *nitida* is one of three *Uvularia* species that occurs in New Jersey (Kartesz 2015). *U. perfoliata* is easily to tell apart from the other two bellworts because the bases of its leaves completely surround the stems. When flowers are present the short (1–2 mm) stigmatic lobes of *U. sessilifolia* can help to separate it from *U. puberula* (Hayashi et al. 1998). Nonflowering plants are best distinguished by the leaves: Those of *U. puberula* are shiny and green on both surfaces while those of *U. sessilifolia* are not shiny and they have a whitish coating on the underside (Young 2012). In parts of its range where both varieties of *U. puberula* occur var. *nitida* is usually separable by its leaves which are thinner, smoother below, and more wedge-shaped at the base (Uttal 1991).

Uvularia puberula typically flowers during May, although a large number of plants in any given population may remain vegetative (Vail et al. 1890, Stone 1911, Hough 1983, Boyd 1991, Gordon 2002, Lamont and Young 2004, Rhoads and Block 2007, NJNHP 2024). Fruits can begin to develop on some of the plants while others are still in bloom (Lamont and Young 2004) but the seeds are retained in the capsules until late summer (Wijesinghe and Whigham 2001, Warren et al. 2017). In *Uvularia*, subterranean buds for the next year's growth form during the fall months, remain dormant throughout the winter, and rapidly expand in the spring (Alden 1912). The aboveground portions of the plants disappear during the winter (Wilbur 1963). The fleshy roots of *U. puberula* can persist for more than one season. They serve as storage organs but can also fulfill an exploratory function that Wijesinghe and Whigham (2001) likened to foraging—the roots elongate faster and branch more frequently when they come into contact with nutrient-rich microsites.

Pollinator Dynamics

No information was found about the pollinators of *Uvularia puberula* but the flowers have nectaries (Wilbur 1963) so they are probably attractive to insects. *Uvularia grandiflora* and *U. sessilifolia* are visited by an assortment of bees and occasional flies, although Andrenid bees appear to be the most effective pollinators (Holm 2014, Hilty 2020). One bee in particular (*Andrena uvulariae*) is a pollen specialist on *Uvularia*. The typical range of the insect extends from New England to North Carolina, although Edens-Meier et al. (2020) recently documented it in Missouri. *A. uvulariae* flies only in May and is considered rare (Fowler and Droege 2020). All of the bees observed on *U. sessilifolia* in North Carolina by Motten (1986) were generalist pollinators. Whigham (1974) reported that *Uvularia perfoliata* was pollinated by flightless Staphylinid beetles before the flowers had fully expanded. Although it seems probable that bees play a role in cross-fertilizing *U. puberula* flowers, differences among the reported pollinators of other bellworts preclude the drawing of inferences about pollination in the species. Outcrossing appears to be prevalent in the genus: When other *Uvularia* species (*U. grandiflora*, *U. perfoliata*,

U. sessilifolia) were experimentally self-pollinated very low levels of fruit set or seed production resulted (Whigham 1974, Motten 1986, McCall and Primack 1987, Edens-Meier et al. 2020).

Seed Dispersal and Establishment

Mature *Uvularia* capsules typically produce 1–3 seeds in each of their three chambers. *U. puberula* seeds are approximately 3 mm in diameter and they have crested arils (Utech and Kawano 2020). The arils, also known as elaiosomes, are lipid-rich and highly attractive to ants. Ants are the primary seed dispersers of *U. puberula* and other *Uvularia* species (Hayashi et al. 1998, Warren et al. 2017). Seeds with elaiosomes are usually collected shortly after dispersal. The ants carry them back to their nests, where they consume the appendages without harming the seeds. The majority of ant-dispersed seeds wind up within a few meters of the parent plants. The seeds that are relocated by ants are protected from predation, and the nests are generally favorable sites for germination (Thompson 1981, Handel and Beattie 1990, Ness et al. 2004).

The germination and establishment requirements of *Uvularia puberula* are not known. The seeds of other *Uvularia* species usually germinate the first spring after dispersal (Whigham 1974, Baskin and Baskin 1988, Deno 1993). A study of *U. perfoliata* found that seedling development proceeded slowly—with only roots forming during the first year and aerial parts appearing in the second year—and that it took several years for the plants to reach reproductive maturity (Whigham 1974). Mycorrhizae have been documented in other members of the family and genus (Smith and Smith 1997, Wang and Qiu 2006) but it is not clear whether fungal associations are important during the seedling stage.

<u>Habitat</u>

Throughout its range, *Uvularia puberula* can be found in moist to dry woodlands at elevations up to 1,500 meters above sea level (Utech and Kawano 2020, Weakley et al. 2024). Szakacs et al. (2022) classified the species as a generalist in terms of shade tolerance and Weakley et al. (2024) assigned it a heliophily ranking of 4 on a scale of 1 (shade obligate) to 9 (sun obligate). *U. puberula* var. *puberula* is often associated with piedmont or mountain sites while var. *nitida* is typically associated with the coastal plain (NCCE 2024).

Uvularia puberula var. *nitida* has been found in comparable habitats in New Jersey, New York, Virginia, and the Carolinas. The communities are frequently described as pine barrens, pine-oak woods, or oak-pine woods. A well developed understory dominated by ericaceous shrubs is often present. *U. puberula* var. *nitida* has been found in open woods or thickets and along the edges of swamps, firebreaks, or roadways. Colonies of the bellwort are often situated in mesic transition zones between swamps and dry uplands (Britton 1889, Fernald 1939, Fables 1957, Breden et al. 2001, Gordon 2002, Lamont and Young 2004, Sorrie et al. 2006, Hernon 2010, Taggart 2010, Young 2012, NJNHP 2024).

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). *Uvularia puberula* has more than one wetland indicator status within the state. In the Atlantic and Gulf Coastal Plain region, *U. puberula* is a facultative species, meaning that it occurs in both wetlands and nonwetlands. In other regions of the state it is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands (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 2024b)

The USDA code for *Uvularia puberula* var. *nitida* is UVPUN2, but the USDA lists the variety as a synonym of *Uvularia puberula* (UVPU2).

Coefficient of Conservancy (Walz et al. 2020)

CoC = 9. 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

The map in Figure 2 depicts the extent of *Uvularia puberula* in North America. According to Fernald (1950), var. *nitida* was found from Long Island to Virginia and the range of var. *puberula* extended from Virginia south to Georgia and Alabama. Since then, both varieties have been reported in North Carolina (Sorrie et al. 2006, Taggart 2010, NCCE 2024) and South Carolina (Uttal 1991).



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



Figure 3. County records of U. puberula in New Jersey and vicinity (USDA NRCS 2024b).

The USDA PLANTS Database (2024b) shows records of *Uvularia puberula* in four New Jersey counties: Atlantic, Burlington, Monmouth, and Ocean (Figure 3 above). Bayard Long also collected the species at two locations in Camden County (Mid-Atlantic Herbaria 2024). The data include historic observations and do not reflect the current distribution of the species.

Conservation Status

Uvularia puberula 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 2024). The map below (Figure 4) illustrates the conservation status of *U. puberula* throughout its range. The species has not been ranked at the varietal level. *Uvularia puberula* is vulnerable (moderate risk of extinction) in Pennsylvania and critically imperiled (very high risk of extinction) in New York. The New Jersey status does not appear on the map because the state listed it as *U. puberula* var. *nitida*.



Figure 4. Conservation status of U. puberula in North America (NatureServe 2024).

Uvularia puberula var. nitida is critically imperiled (S1) in New Jersey (NJNHP 2024). The rank usually 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. *U. puberula* var. *nitida* 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. In this case the state rank and status appear to reflect the relative rarity of the variety, which was previously ranked as globally vulnerable when it was recognized by NatureServe (NJNHP 2024). 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 the bellwort 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).

Uvularia puberula var. *nitida* is restricted to the Pine Barrens in New Jersey (Rapa 2005). Nathaniel Lord Britton first documented the species in Ocean County during 1887, collecting it at two sites (Britton 1889). Throughout the century that followed the bellwort was found at about two dozen additional locations around the state but it continued to be characterized as rare and local (Mackenzie 1908, Long 1909, Stone 1911, Fables 1958). Although Fairbrothers and Hough (1973) omitted *U. puberula* from their list of rare New Jersey plants, Hough (1983) subsequently identified it as an endangered species. Pine Barren Bellwort was one of 44 plants listed as Priority 1 for protection by the state (NJONLM 1984) and was included on New Jersey's first official list of endangered flora (NJONLM 1990). After the initial listing at least ten new occurrences were discovered, and the species was ranked as S2 (imperiled) from 1992 to 2022 (NJONLM 1992, NJNHP 2022). The Natural Heritage Program currently tracks 18 populations as extant and 23 as historical, but many of the extant populations are small and several have not been relocated (Gordon 2002, 2013, 2015; Schuyler and Gordon 2002, Zampella et al. 2004). The status of the species was recently changed to critically imperiled (NJNHP 2024).

Threats

Populations of *Uvularia puberula* var. *nitida* in the New Jersey Pine Barrens may face an assortment of threats depending on their location. While some of the extant occurrences appear to be relatively secure, potential concerns noted for others have included roadside maintenance, off-road vehicles, foot traffic, invasive plants, flooding by beavers, and deer. At least one population appears to have been destroyed by the scraping of vegetation along the edge of a road (Gordon 2002, NJNHP 2024), and other roadside occurrences have experienced repeated disturbances from mowing or parking along the shoulder.

Canopy closure has been identified as a possible threat at some sites. Although Pine Barren Bellwort can persist shady locations it is often more abundant in gaps and along edges. *Uvularia puberula* is tolerant of fire and appears to benefit from prescribed burns (Harrod et al. 2000, Binninger 2016, Benz 2020). During one study the bellwort was documented at a location that had been cleared and burned but it was not recorded there prior to the management activity and it was absent from an unburned reference site (Ulyshen et al. 2022).

Herbivory by White-tailed Deer (*Odocoileus virginianus*) is likely to threaten some New Jersey populations and that has also been identified as a concern for *Uvularia puberula* in Pennsylvania (PANHP 2019). Although deer exclosures did not appear to make a difference in the bellwort's abundance during a study in Virginia (Wilbur et al. 2017), plants in the Liliales are highly palatable and often preferentially browsed. Detrimental impacts to other *Uvularia* species have been reported as a result of grazing (Miller et al. 1992, Balgooyen and Waller 1995, Huebner et al. 2010, Waller and Maas 2013).

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Uvularia puberula* var. *nitida* populations 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 Pine Barren Bellwort was assessed as Less Vulnerable, meaning that climate change is not expected to have a notable detrimental impact on its extent in New Jersey by 2050. However, much is still unknown about the species' ecological requirements so its vulnerability may have been underestimated.

Shifting climactic conditions in New Jersey are resulting in higher temperatures, more frequent and intense precipitation events, and increasing periods of drought (Hill et al. 2020). It is not clear whether *U. puberula* can alter the timing of key life history events in response to environmental cues, and the bellwort's tolerance for inundation or desiccation have not been studied. As an ant-dispersed species, *U. puberula* probably has a limited capacity for northward range expansion because its propagules are not moved over long distances between generations. As the climate continues to warm, synchrony between seed release and periods of high ant activity may be disrupted (Warren et al. 2017). Warmer temperatures might also facilitate the introduction of different ant species in the region, which could affect seed dispersal distances and frequency (Ness et al. 2004).

Management Summary and Recommendations

Potential differences between the varieties of *Uvularia puberula* do not appear to have been evaluated at the molecular level. Genetic studies might provide taxonomic clarity as well as some indication of how resilient the species is likely to be in the face of change. Other suggested topics for research on *U. puberula* include pollinators, self-compatibility, germination and establishment requirements, plant development and lifespan, herbivory impacts, competitive abilities, and adaptability to shifts in environmental conditions.

No urgent management needs have been identified for *Uvularia puberula* in New Jersey. Few threats have been noted during recent surveys and half of the 18 extant populations have been monitored within the past decade. Another 23 populations are ranked as historical because suitable habitat is thought to be present and the majority of those sites have not been searched so the bellwort might still persist in some additional locations.

Synonyms and Taxonomy

The accepted botanical name of the species is *Uvularia puberula* var. *nitida* (Britton) Fernald. Orthographic variants, synonyms, and common names are listed below (Fernald 1935, POWO 2024). Northern specimens of *U. puberula* were noted to share some characteristics with typical plants in that genus and with *U. sessilifolia* but to differ from both, and their identity was eventually resolved by naming them as a variety of the former species (Britton 1889, Mackenzie 1908, Long 1909, Fernald 1935). Wilbur (1961, 1963) noted that *U. puberula* plants with similar features could be found throughout the species' range and argued that the varieties were not distinct enough to warrant taxonomic ranking. Uttal (1991) thought the varieties were distinct but noted that they sometimes backcrossed in the Carolinas. Many current sources do not recognize any varieties of *U. puberula* (eg. Kartesz 2015, Utech and Kawano 2020, ITIS 2024, NatureServe 2024, POWO 2024, USDA 2024b). Weakley et al. (2024) observed that differences between the two varieties appeared to be minor, inconsistent, and poorly correlated with their distribution.

Botanical Synonyms

Common Names

Oakesia sessilifolia var. nitida Britton Oakesiella nitida (Britton) A. Heller Uvularia nitida (Britton) Mack. Uvularia pudica var. nitida (Britton) Fernald Uvularia sessilifolia var. nitida (Britton) Morong Pine Barren Bellwort Shining Bellwort

References

Alden, Isabel. 1912. A contribution to the life history of *Uvularia sessilifolia*. Bulletin of the Torrey Botanical Club 39(9): 439–446.

Balgooyen, C. P. and D. M. Waller. 1995. The use of *Clintonia borealis* and other indicators to gauge impacts of White-tailed Deer on plant communities in northern Wisconsin, USA. Natural Areas Journal 15: 308–318.

Baskin, Carol C. and Jerry M. Baskin. 1988. Germination ecophysiology of herbaceous plant species in a temperate region. American Journal of Botany 75(2): 286–305.

Benz, Brandy Lyn. 2020. Ground-Layer Vegetation Response to Silvicultural Treatments for Oak (*Quercus*) Regeneration in Southern Appalachian Forests. Master's Thesis, North Carolina State University, Raleigh, NC. 118 pp.

Binninger, Sean K. 2016. Herb Abundance and Diversity Among Fire Severity Classes in Pine-Oak Forests of Great Smoky Mountains National Park. Master's Thesis, Western Carolina University, Cullowhee, NC. 81 pp.

Boyd, Howard P. 1991. A Field Guide to the Pine Barrens of New Jersey: Its Flora, Fauna, Ecology and Historic Sites. Plexus Publishing, Inc., Medford, NJ. 423 pp.

Boyd, Amy E. and Isaiah M. Thalmayer. 2014. Phylogenetic relationships within *Uvularia* (Colchicaceae) based on morphology. Journal of the North Carolina Academy of Science, 130(3–4): 116–121.

Breden, Thomas F., Yvette R. Alger, Kathleen Strakosch Walz, and Andrew G. Windisch. 2001. Classification of Vegetation Communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry, NJ Department of Environmental Protection, Trenton, NJ. 230 pp.

Britton, N. L. 1889. New or noteworthy North American phanerogams, II. Transactions of the New York Academy of Sciences 9: 6–15.

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.

Deno, Norman C. 1993. Seed Germination Theory and Practice. Second Edition. Pennsylvania State University, State College, PA. 242 pp.

Dietz, Robert A. 1952. Variation in the perfoliate *Uvularias*. Annals of the Missouri Botanical Garden 39(3): 219–247.

Edens-Meier, Retha, Michael Arduser, Gerardo R. Camilo, Peter Bernhardt, and Zong-Xin Ren. 2020. Breeding systems and pollination ecology of *Uvularia grandiflora* (Colchicaceae). Journal of the Torrey Botanical Society 147(1): 38–48.

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

Fables, David Jr. 1957. Caesarian flora and fauna, Number 3. Published posthumously in Bartonia 32(1961–62): 7–10.

Fables, David Jr. 1958. Caesarian flora and fauna, Number 4. Published posthumously in Bartonia 32(1961–62): 11–13.

Fairbrothers, David E. and Mary Y. Hough. 1973. Rare or Endangered Vascular Plants of New Jersey. Science Notes No. 14, New Jersey State Museum, Trenton, NJ. 53 pp.

Fernald, M. L. 1935. Midsummer vascular plants of southeastern Virginia. Rhodora 37: 378–413.

Fernald, M. L. 1939. Last survivors in the flora of Tidewater Virginia (continued). Rhodora 41: 465–504 and 529–550.

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

Fowler, Jarrod and Sam Droege. 2020. Pollen specialist bees of the eastern United States. Available at <u>https://jarrodfowler.com/specialist_bees.html</u>

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.

Gordon, Ted. 2002. 1997–1999 field trips. Bartonia 61: 155–173.

Gordon, Ted. 2013. 2009–2011 field trips. Bartonia 66: 82–119.

Gordon, Ted. 2015. 2012–2013 field trips. Bartonia 67: 92–122.

Hafstad, Jason. 2017, 2021. Interior (2017) and cover (2021) photos of *Uvularia puberula* var. *nitida*. Used with permission.

Handel, Steven N. and Andrew J. Beattie. 1990. Seed dispersal by ants. Scientific American 263(2): 76–83.

Harrod, J. C., M. E. Harmon, and P. S. White. 2000. Post-fire succession and 20th century reduction in fire frequency on xeric southern Appalachian sites. Journal of Vegetation Science 11: 465–472.

Hayashi, Kazuhiko, Seiji Hidetoshi Kato, Frederick H. Utech, Dennis F. Whigham, and Shoichi Kawanoi. 1998. Molecular systematics of the genus *Uvularia* and selected Liliales based upon matK and rbcL gene sequence data. Plant Species Biology 13(2–3): 129–146.

Hernon, Brittany. 2010. The Effect of Overstory Composition and Cover on Understory Makeup in the Long Island Solar Farm Area. Science Undergraduate Laboratory Internship (SULI) Report, Office of Science, Brookhaven National Laboratory, Upton, NY. 15 pp.

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. Flower-visiting insects. Illinois Wildflowers. Accessed September 26, 2024 at <u>https://www.illinoiswildflowers.info/flower_insects/plants/large_bellwort.htm</u> and <u>https://www.illinoiswildflowers.info/flower_insects/plants/sl_bellwort.htm</u>

Holm, Heather. 2014. Pollinators of Native Plants. Pollination Press, Minnetonka, MN. 301 pp.

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

Huebner, Cynthia D., Kurt W. Gottschalk, Gary W. Miller, and Patrick H. Brose. 2010. Restoration of three forest herbs in the Liliaceae family by manipulating deer herbivory and overstorey and understorey vegetation. Plant Ecology and Diversity 3(3): 259–272. ITIS (Integrated Taxonomic Information System). Accessed September 22, 2024 at <u>http://www.itis.gov</u>

Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (<u>http://www.bonap.net/tdc</u>). 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)].

Lamont, Eric E. and Stephen M. Young. 2004. Noteworthy plants reported from the Torrey Range: 2002 and 2003. The Journal of the Torrey Botanical Society 131(4): 394–402.

Long, Bayard. 1909. *Pinus serotina* Michx. in southern New Jersey and other local notes. Bartonia 2: 17–21.

Mackenzie, Kenneth K. 1908. The Pine-barren Bellwort. Torreya 8(1): 13-14.

McCall, C. and R. B. Primack. 1987. Resources limit the fecundity of three woodland herbs. Oecologia 71: 431–435.

Mid-Atlantic Herbaria. 2024. Accessed at <u>https://midatlanticherbaria.org/portal/index.php</u> on September 23, 2024.

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.

Motten, Alexander F. 1986. Pollination ecology of the spring wildflower community of a temperate deciduous forest. Ecological Monographs 56(1): 21–42.

NatureServe. 2024. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed September 22, 2024 at <u>https://explorer.natureserve.org/</u>

NCCE (North Carolina Cooperative Extension). 2024. *Uvularia puberula*. North Carolina Extension Gardener Plant Toolbox, accessed September 23, 2024 at https://plants.ces.ncsu.edu/plants/uvularia-puberula/

Ness, J. H., J. L. Bronstein, A. N. Anderson, and J. N. Holland. 2004. Ant body size predicts dispersal distance of ant-adapted seeds: Implications of small-ant invasions. Ecology 85(5): 1244–1250.

NJNHP (New Jersey Natural Heritage Program). 2010. Explanation of Codes Used in Natural Heritage Reports. Updated March 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2022. List of Endangered Plant Species and Plant Species of Concern. Biotics Database. NatureServe, Arlington, Virginia. Accessed September 2022.

NJNHP (New Jersey Natural Heritage Program). 2024. Biotics 5 Database. NatureServe, Arlington, VA. Accessed March 15, 2024.

NJONLM (New Jersey Office of Natural Lands Management). 1984. New Jersey's Threatened Plant Species. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Trenton, NJ. 14 pp.

NJONLM (New Jersey Office of Natural Lands Management). 1990. State of New Jersey Endangered Plant Species List. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Trenton, NJ. 10 pp.

NJONLM (New Jersey Office of Natural Lands Management). 1992. Special Plants of New Jersey. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Trenton, NJ. 22 pp.

PANHP (Pennsylvania Natural Heritage Program). 2019. Species and Natural Features List. Fact sheet for *Uvularia puberula* available at https://www.naturalheritage.state.pa.us/factsheet.aspx?=15408

POWO. 2024. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed September 22, 2024 at <u>http://www.plantsoftheworldonline.org/</u>

Rapa, Francis (ed). 2005. Commission to strengthen protection of rare plants. The Pinelander (Winter 2004/2005): Newsletter of the New Jersey Pinelands Commission: 1.

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

Ring, Richard M., Elizabeth A. Spencer, and Kathleen Strakosch Walz. 2013. Vulnerability of 70 Plant Species of Greatest Conservation Need to Climate Change in New Jersey. New York Natural Heritage Program, Albany, NY and New Jersey Natural Heritage Program, Department of Environmental Protection, Office of Natural Lands Management, Trenton, NJ, for NatureServe #DDCF-0F-001a, Arlington, VA. 38 pp.

Schuyler, Alfred E. and Ted Gordon. 2002. Rare plants in the Middle Branch of the Forked River watershed, Lacey Township, Ocean County, New Jersey. Bartonia 61: 117–121.

Smith, F. A. and S. E. Smith. 1997. Tansley Review No. 96: Structural diversity in (vesicular)-arbuscular mycorrhizal symbioses. New Phytologist 137: 373–388.

Sorrie, Bruce A., Janet Bracey Gray, and Philip. J. Crutchfield. 2006. The vascular flora of the Longleaf Pine ecosystem of Fort Bragg and Weymouth Woods, North Carolina. Castanea 71(2): 127–159.

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

Szakacs, Alexandria D., Alexander Krings, and Thomas R. Wentworth. 2022. Shade-tolerance classification of the upland herbaceous flora of the Carolina and Virginia Piedmont. The American Midland Naturalist 187(2): 113–147.

Taggart, John B. 2010. The vascular flora of Sandy Run Savannas State Natural Area, Onslow and Pender Counties, North Carolina. Castanea 75(4): 484–499.

Thompson, John N. 1981. Elaiosomes and fleshy fruits: Phenology and selection pressures for ant-dispersed seeds. The American Naturalist 117(1): 104–109.

Ulyshen, Michael, Katherine Elliott, Joel Scott, Scott Horn, Patsy Clinton, Ning Liu, Chelcy F. Miniat, Peter Caldwell, Chris Oishi, Jennifer Knoepp, and Paul Bolstad. 2022. Effects of *Rhododendron* removal and prescribed fire on bees and plants in the southern Appalachians. Ecology and Evolution 123): e 8677.

U. S. Army Corps of Engineers. 2020. National Wetland Plant List, version 3.5. <u>https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html</u> 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). 2024a. *Uvularia puberula* 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 (<u>http://plants.usda.gov</u>). National Plant Data Team, Greensboro, NC.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2024b. PLANTS profile for *Uvularia puberula* (Mountain Bellwort). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed September 23, 2024 at <u>http://plants.usda.gov</u>

Utech, Frederick H. and Shoichi Kawano. Page updated November 6, 2020. *Uvularia puberula* Michaux. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed September 22, 2024 at http://floranorthamerica.org/Uvularia_puberula

Uttal, Leonard J. 1991. Scientific Note: Notes on *Uvularia puberula* Michaux (Liliaceae). Castanea 56(1): 70.

Vail, Anna Murray, N. L. Britton, Elizabeth G. Britton and Arthur Hollick. 1890. Notes on the spring flora of southwestern Virginia. Memoirs of the Torrey Botanical Club 2(2): 27-56.

Waller, Donald M. and Lisa I. Maas. 2013. Do white-tailed deer and the exotic plant garlic mustard interact to affect the growth and persistence of native forest plants? Forest Ecology and Management 304: 296–302.

Walz, Kathleen S., Jason L. Hafstad, Linda Kelly, and Karl Anderson. 2020. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera (update to 2017 list). New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ.

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

Warren, Robert J. II, Joshua R. King, Lacy D. Chick, and Mark A. Bradford. 2017. Global change impacts on ant-mediated seed dispersal in eastern North American forests. <u>In</u> Paulo S. Oliveira and Suzanne Koptur (eds.), Ant-Plant Interactions: Impacts of Humans on Terrestrial Ecosystems. Cambridge University Press, United Kingdom.

Watson, Sereno. 1879. Contributions to American botany: Revision of the North American Liliaceæ; Descriptions of some new species of North American plants. Proceedings of the American Academy of Arts and Sciences 14: 213–303.

Weakley, A. S. and Southeastern Flora Team. 2024. Flora of the Southeastern United States. Edition of March 4, 2024. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC. 2023 pp.

Whigham, D. F. 1974. An ecological life history study of *Uvularia perfoliata* L. American Midland Naturalist 91: 343–359.

Wijesinghe, D. K. and D. F. Whigham. 2001. Nutrient foraging in woodland herbs: A comparison of three species of *Uvularia* (Liliaceae) with contrasting belowground morphologies. American Journal of Botany 88: 1071–1079.

Wilbur, Robert L. 1961. A new name for the puberulent sessile-leaved *Uvularia*. Rhodora 63(746): 36–39.

Wilbur, Robert L. 1963. A revision of the North American genus *Uvularia* (Liliaceae). Rhodora 65: 158–188.

Wilbur, Henry M., Katie L. Burke, Rebecca B. Wilbur and Annie Rosenbauer. 2017. Recovery of the herb layer in a southern Appalachian forest following chronic herbivory by deer (*Odocoileus virginianus*). Castanea 82(2): 98–113.

Young, Stephen M. 2012. New York Natural Heritage Program online conservation guide for *Uvularia puberula*. Accessed December 18, 2023 at <u>https://guides.nynhp.org/pine-barren-bellwort/</u>

Young, Bruce E., Elizabeth Byers, Geoff Hammerson, Anne Frances, Leah Oliver, and Amanda Treher. 2016. Guidelines for Using the NatureServe Climate Change Vulnerability Index, Release 3.02, 1 June 2016. NatureServe, Arlington, VA. 65 pp.

Zampella, Robert A., Nicholas A. Procopio, Kim J. Laidig, and John F. Bunnell. 2004. The Essential Character of the Oyster Creek Watershed. New Jersey Pinelands Commission, New Lisbon, NJ. 17 pp.