

Sanicula trifoliata

Large-fruit Black-snakeroot

Apiaceae



Sanicula trifoliata by J. W. Harrison, 2022

***Sanicula trifoliata* 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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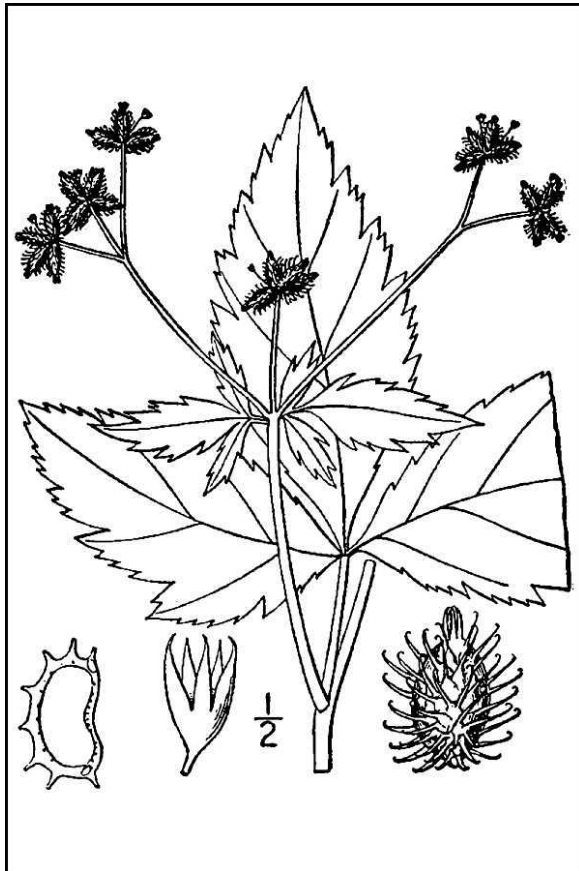
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Life History

Large-fruit Black-snakeroot (*Sanicula trifoliata*) is a facultative biennial (MNDNR 2023) in the Apiaceae/Umbellaceae (Parsley) family. Facultative biennials are short-lived perennials that can reproduce in two years in fertile soil if there is minimal competition for resources, but otherwise take a longer time to reproduce. Rather than reaching a particular age (e.g., two years) for reproduction, the plants need to attain a certain size (Klemow and Raynal 1985). Once seeds are produced, that plant dies.

Sanicula trifoliata grows 30–75 cm tall on a single erect slender stem, with alternate branching and compound leaves. The palmate leaves are divided into three leaflets (or lobes) with toothed margins, although the outer leaflets are usually cleft partway to the midrib. (In *S. canadensis*, the lateral leaflets are more strongly cleft and narrower.) Each leaflet is obovate, about 7.5 to 10 cm long and 4 cm wide (Britton and Brown 1913; LeGrand et al. 2023). The lower stem leaves are larger with long petioles, whereas the upper leaves are reduced in size, either sessile or with short petioles (MNDNR 2023; Native Plant Trust 2023).



Left: Britton and Brown 1913, courtesy USDA NRCS 2022a. Right: Peter M. Dziuk, 2016.

The flowers are white to greenish white (Newcomb 1977) with five obovate (or narrower) petals and five sepals, each unfused. The small flowers are clustered at the ends of the rays forming an umbel with 1–7 staminate flowers on long stalks up to 8 mm above the sessile pistillate or bisexual flowers (Gleason and Cronquist 1963; MNDNR 2023; Weakley et al. 2022). In New

Jersey, *S. trifoliata* blooms from mid-June to August but can bloom as early as May, depending on location (Gleason and Cronquist 1963; Hough 1983; LeGrande et al. 2023; Strausbaugh and Core 1978; Weakley et al. 2022). The seeds are borne in bur-like fruits with hooked bristles, which do not split open when ripe (Native Plant Trust 2023). *Sanicula trifoliata* is characterized by having flower styles shorter than the calyx, where the sepals form a beak-like structure 2–2.5 mm in length that usually extends beyond the uppermost bristles of the fruit (Gleason and Cronquist 1963; MNDNR 2023; Weakley et al. 2022).



Will Van Hemessen, 2021.



Vanessa Volker, 2018.

Pollinator Dynamics

There is no specific information available about pollinators of *S. trifoliata*; however, other closely related woodland *Sanicula* (*S. canadensis* and *S. odorata*) are visited by a variety of insect pollinators. The most important of those include long-tongued bees in the Apidae, Anthophoridae and Megachilidae families, short-tongued bees in the Halictidae, Andrenidae, and Colletidae families and the two Syrphid fly species (*Toxomerus germinatus* and *T. marginatus*) (Robertson 1929; Wilhelm and Rericha in Hilty 2020).

Seed Dispersal

The fruits of *Sanicula trifoliata* mature in the late summer or early fall (August/Sept) (MNDNR 2023), though earlier (June/July) in more southern portions of the range (LeGrande et al. 2023). Ovoid to subglobose and sometimes slightly flattened, the fruits are 6–8 mm long and densely covered with hooked bristles that may be arranged in rows (Gleason and Cronquist 1963; Native Plant Trust 2023). The fruits (and seeds) are most likely transported by passing animals such as deer or birds as the bristles become entangled in the fur or feathers (Hilty 2020; MNDNR 2023). According to Hawkins et al. (2007), because the fruits remain on the stalk over the winter and into the following spring or longer the seed dispersal period can last for over a year. In addition, experimental plantings demonstrated that most of the seeds of *S. trifoliata* did not germinate until

the second spring and there were some instances where germination was delayed for up to six years. This could potentially allow for the establishment of a short-term persistent seedbank if conditions are suitable (Hawkins et al. 2007). The plant does not appear to reproduce vegetatively; there are no bulbils, bulblets or stolons (Native Plant Trust 2023). However, although mainly spreading by seeds, the related *S. canadensis* does occasionally form colonies (Hilty 2020) and *S. trifoliata* may do the same.

Habitat

Sanicula trifoliata prefers mature, nutrient-rich, mesic forests in riparian habitats to drier upland woods, often in calcareous or mafic soils (Clemants and Gracie 2006; MNHP 2021; Native Plant Trust 2023). In the southeastern United States Large-fruit Black-snakeroot is found in cove forests (Weakley et al. 2022). In Ohio and in northern Canada, this species is considered an indicator of mature, old growth forests (Olivera and Hix 1998; Pryer and Phillippe 1989, respectively) where it is often found on northeast-facing slopes (Olivera and Hix 1998). In Minnesota, the species has a strong correlation with north-facing slopes in closed canopy forests of Sugar Maple (*Acer saccharum*), American Basswood (*Tilia americana*), and Northern Red Oak (*Quercus rubra*) (MNDNR 2023). In New England, the species is found in calcareous deciduous woods at low elevations (less than 457 m [1,500 feet]) usually on steep slopes. There it typically grows in closed canopy forests with a dense vegetative native ground cover, although it can sometimes be found at the edges of clearings or near outcrops with some sun exposure (USDA Forest Service 2002).

In New Jersey, populations have been found on an open wooded limestone hillside, in moist soil along a trail at the base of a wooded limestone ridge, at the edge of a road in traprock woods, and in a mesic ravine at the foot of a wooded traprock ridge and talus slope (NJNHP 2022). Associated species at the traprock mesic ravine site included Sugar Maple (*Acer saccharum*), Black Birch (*Betula lenta*), Northern Spicebush (*Lindera benzoin*), American Bladdernut (*Staphylea trifolia*) and an understory herbaceous layer of Marginal Wood Fern (*Dryopteris marginalis*), Christmas Fern (*Polystichum acrostichoides*), Herb Robert (*Geranium robertianum*), Canadian Wild Ginger (*Asarum canadense*), Round-lobed Hepatica (*Hepatica nobilis* var. *obtusata*) and various violets (*Viola* spp.) (NJNHP 2022). Plants have also been found on a south-facing slope above the Paulins Kill with exposed large tree roots and areas of rich soil with deep litter. *Sanicula trifoliata* was growing in the upper drier section of the slope. Some associated canopy species at that location included Sugar Maple (*Acer saccharum*), American Basswood (*Tilia americana*), Green Ash (*Fraxinus pennsylvanica*), Black Walnut (*Juglans nigra*), White Oak (*Quercus alba*) and American Sycamore (*Platanus occidentalis*) with shrubs including Northern Spicebush (*Lindera benzoin*) and Southern Arrow-wood (*Viburnum dentatum*) (NJNHP 2022).

Most terrestrial plants exhibit a symbiotic relationship with mycorrhizal fungi. Wang and Qiu's 2006 review of the literature identified one *Sanicula* species (*S. europaea*) that had an association with arbuscular mycorrhizae (see also Grünfeld et al. 2020 for detailed discussion). *Sanicula gregoria* (= *odorata*) (Anderson et al. 2010), and the western species *S. crassicaulis* and *S. graveolens* (Godoy and Marín 2019) also have been reported to have mycorrhizal

associations. Because several *Sanicula* species are mycorrhizal, it is possible that *S. trifoliata* also has an association with arbuscular mycorrhizae.

Wetland Indicator Status

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

USDA Plants Code (USDA, NRCS 2022b)

SATR4

Coefficient of Conservatism (Walz et al. 2018)

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 global range of *Sanicula trifoliata* is restricted to the United States and Canada (POWO 2022). The map in Figure 1 depicts the extent of Large-fruit Black-snakeroot in the North America.

The USDA PLANTS Database (2022b) shows records of *Sanicula trifoliata* in seven New Jersey counties: Essex, Hunterdon, Mercer, Passaic, Somerset, Sussex, and Warren (Figure 2). *S. trifoliata* has also been collected in Union County (Mid-Atlantic Herbaria 2022). The data include historic observations and do not reflect the current distribution of the species.

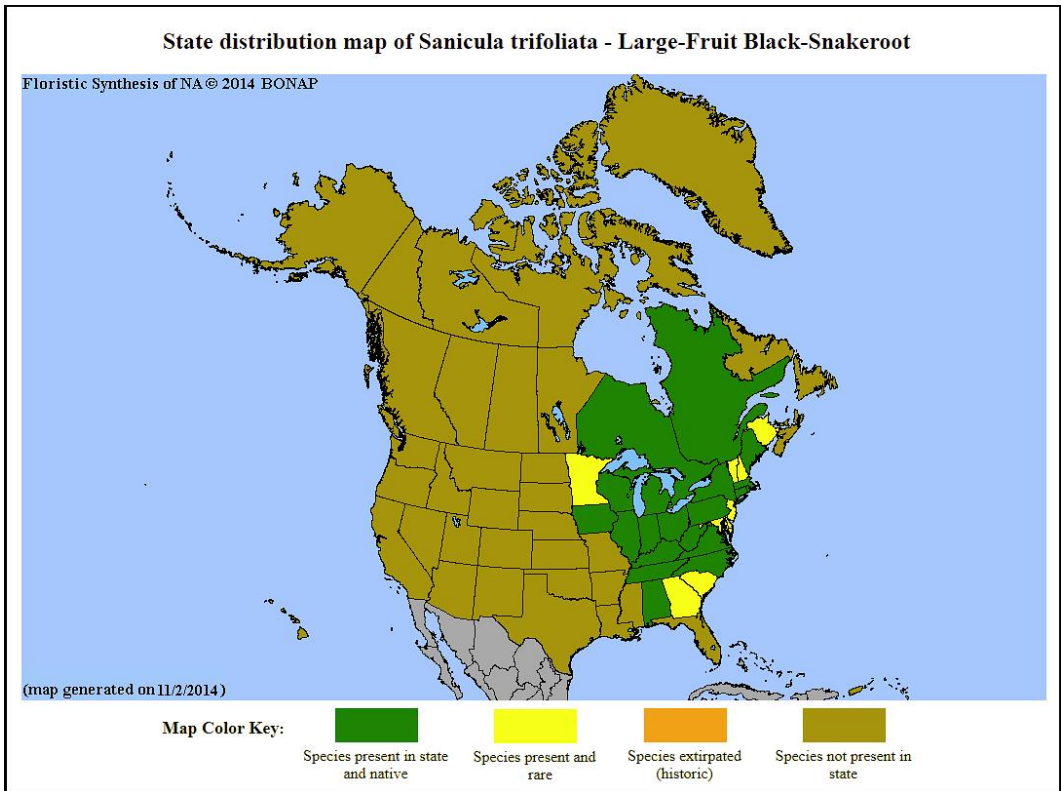


Figure 1. Distribution of *S. trifoliata* in North America, adapted from BONAP (Kartesz 2015).

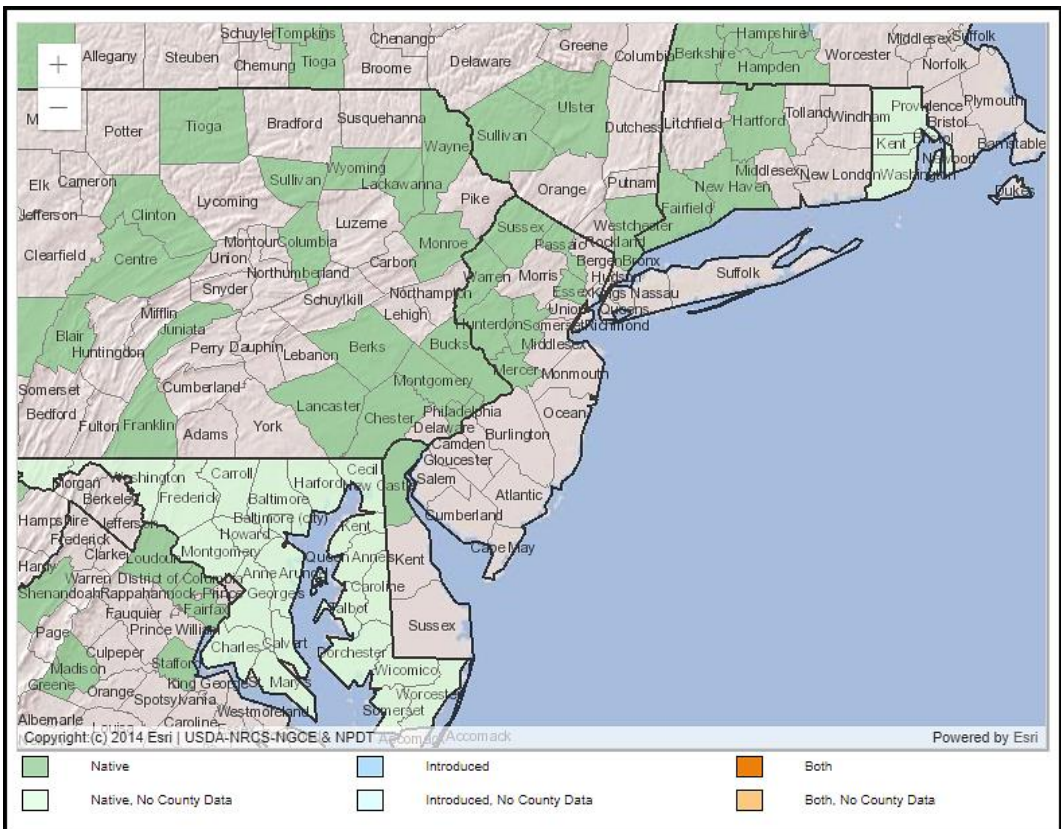


Figure 2. County records of *S. trifoliata* in New Jersey and vicinity (USDA NRCS 2022b).

Conservation Status

Sanicula trifoliata is apparently secure at a global scale. 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, although there is some cause for concern as a due to recent local declines, threats, or other factors (NatureServe 2022). The map below (Figure 3) illustrates the conservation status of *S. trifoliata* throughout its range. Large-fruit Black-snakeroot is critically imperiled (very high risk of extinction) in four states, imperiled (high risk of extinction) in two states and one province, and vulnerable (moderate risk of extinction) in five states and one province. The most vulnerable populations are located at the periphery of the range for the species. Throughout the core of the range, it is considered secure, apparently secure, or unranked.

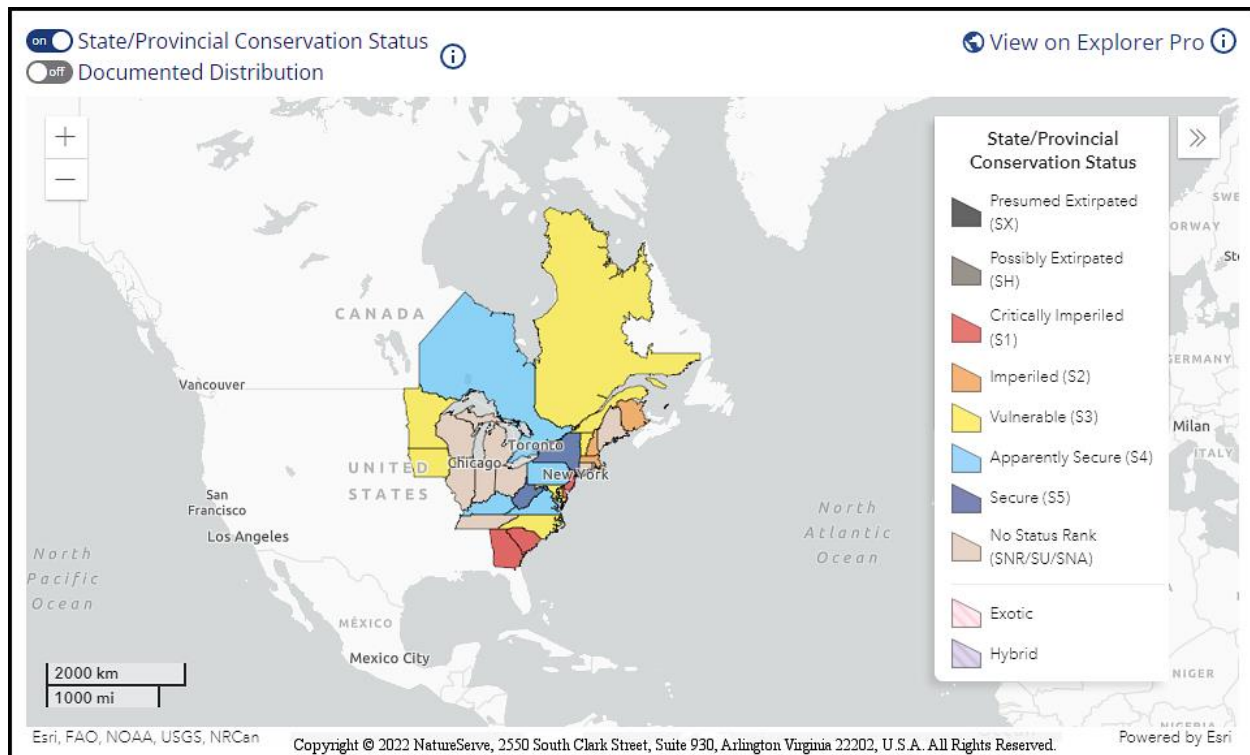


Figure 3. Conservation status of *S. trifoliata* in North America (NatureServe 2022).

New Jersey is one of the states where *Sanicula trifoliata* 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. *S. trifoliata* 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 the plant signify that the species is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010). New Jersey has eight element occurrences, of these five are considered extant, two are historical (due to potential unsearched habitat at both locations), and one population is considered extirpated.

Threats

Non-native invasive species have been identified as a threat throughout the range of Large-fruit Black-snakeroot. In New Jersey populations, non-native invasive plant species observed include Morrow's Honeysuckle (*Lonicera morrowi*), Japanese Barberry (*Berberis thunbergia*), Wine Raspberry (*Rubus phoenicolasius*), Japanese Stiltgrass (*Microstegium viminium*) and Garlic Mustard (*Alliaria petiolata*). Garlic mustard has been shown to negatively affect the arbuscular mycorrhizal community associated with *Sanicula gregraria* (= *odorata*) (Anderson et al. 2010). Another non-native plant species that has been identified as a threat elsewhere is European Buckthorn (*Rhamnus cathartica*). Animals such as non-native earthworms introduced from Europe and Asia also reduce the integrity of interior forests that evolved in their absence. Through their burrowing activity and consumption and removal of the leaf litter layer earthworms alter forest soil structure and nutrient cycling and affect the mycorrhizal community. This has led to the loss of many forest understory herbs where invasions have occurred and is a potential threat to *Sanicula trifoliata* (Bolen et al. 2004; MNDNR 2023).

In Minnesota, apart from invasive non-native species, the main threats to *Sanicula trifoliata* populations are activities that threaten the mesic forest communities in which *S. trifoliata* is found. Such activities include livestock grazing, any timbering that opens large gaps in the forest canopy or disturbs the soil, or motorized vehicle recreation (e.g., off-road vehicles [ORVs]) in otherwise undisturbed forests (MNDNR 2023). Similarly, the Southern Appalachian Species Viability Project (NatureServe 2022) considers logging and site preparation to be harmful to this species.

Loss of habitat to development (especially of low elevation rich hardwood forests in New England) or habitat fragmentation have also been identified as threats to the species (USDA Forest Service 2002; NatureServe 2022), although genetic isolation has not been mentioned as a concern at this time. In New Jersey one population has been lost to development and urbanization (Breden et al. 2006). Neither disease nor herbivory are currently mentioned as threats to the species. Research by Augustine (1997) showed that *Sanicula* species in his study were rarely foraged by deer and according to Hilty (2020) the leaves of some *Sanicula* species are bitter and avoided by livestock.

Climate change is an overarching challenge in all habitats. New Jersey is projected to become warmer and wetter with altered precipitation patterns that may lead to hotter drier summers and periods of summer drought (NJDEP 2020). While *Sanicula trifoliata* prefers mesic habitats it is also found in drier upland forest; those populations on drier, more exposed slopes may become stressed in the coming years. As facultative biennials (see Life History), under less optimal conditions plants may take longer to reach maturity, which could result in smaller population sizes over time.

Management Summary and Recommendations

In Minnesota, management of *Sanicula trifoliata* depends primarily on good management of mesic hardwood forests. The Minnesota Department of Natural Resources recommends curtailing domestic livestock grazing, timber harvesting practices that open the canopy to allow

the encroachment of invasive non-native species, and motorized vehicle access into sensitive forest habitats (MNDNR 2023).

Regular monitoring of *Sanicula trifoliata* occurrences will help detect new encroachments of non-native species and address the spread as quickly as possible (MNDNR 2023). In the Clove at High Mountain, New Jersey *Alliaria petiolata* was found in the vicinity of the element occurrence during a 2012 site visit. The recommendations at the time included closing that section of adjacent trail to foot traffic and ORV access to prevent the spread of seeds into the core of the population. While disease or herbivory have not been determined to be of concern, regular monitoring would ensure that should either become evident control measures or other management could be implemented to protect the plants.

In New Jersey, the two element occurrences ranked as historic should be revisited and potential habitat thoroughly surveyed to determine whether those populations remain extant or should be considered extirpated. Additional research on important pollinators, potential mycorrhizal associations, and any other germination requirements for this species may be useful. The future effects of climate change on existing element occurrences in New Jersey are not clear. It may be that populations nearer to permanent streams will persist if the forest community remains intact whereas populations in drier habitats or where forest health is in decline will be lost. Overall, forest management that protects the integrity of the canopy and preserves the older mesic forest community will be the best insurance for the continued persistence of the species in New Jersey.

Synonyms

The accepted botanical name of the species is *Sanicula trifoliata* E. P. Bicknell. Orthographic variants, synonyms, and common names are listed below (ITIS 2022; Newcomb 1977; POWO 2022; USDA NRCS 2022b; Weakly et al. 2022).

Botanical Synonyms

Common Names

Large-fruit Black-snakeroot
Large-fruit Sanicle
Beaked Sanicle
Beaked Snakeroot
Long-fruited Snakeroot
Three-leaved Black Snakeroot

References

Anderson, R. C., M. R. Anderson, J. T. Bauer, M. Slater, J. Herold, P. Baumhardt and V. Borowicz. 2010. Effect of removal of garlic mustard (*Alliaria petiolata*, Brassicaceae) on arbuscular mycorrhizal fungi inoculum potential in forest soils. *The Open Ecology Journal* 2010 (3): 41–47.

Augustine, D. J. 1997. Grazing patterns and impacts of white-tailed deer in a fragmented forest ecosystem. PhD Thesis, University of Minnesota, St. Paul, MN.

Bohlen, Patrick J., Stephan Scheu, Cindy M. Hale, Mary Ann McLean, Sonja Migge, Peter M. Groffman and Dennis Parkinson. 2004. Non-native earthworms as agents of change in northern temperate forests. *Frontiers in Ecology and the Environment* 2(8): 427–435.

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.

Britton, N. L. and A. Brown. 1913. *An Illustrated Flora of the Northern United States and Canada in three volumes: Volume II (Amaranth to Polypremum)*. Second Edition. Reissued (unabridged and unaltered) in 1970 by Dover Publications, New York, NY. 735 pp.

Clemants, S. and C. Gracie. 2006. *Wildflowers in the Field and Forest: a Field Guide to the Northeastern United States*. Oxford University Press, New York, NY. 445 pp.

Dziuk, Peter M. 2016. *Sanicula trifoliata*. Image courtesy of Minnesota Wildflowers, <https://www.minnesotawildflowers.info/flower/beaked-snakeroot> licensed by <https://creativecommons.org/licenses/by-nc-nd/3.0/>.

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

Gleason, H. A. and A. Cronquist. 1963. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. Willard Grant Press, Boston, MA. 810 pp.

Godoy, R. and C. Marín. 2019. Chapter 16: Mycorrhizal studies in temperate rainforests of southern Chile. In M. C. Pagano and M. A. Lugo (eds.). *Mycorrhizal Fungi in South America*, pp. 315–341. Springer Nature, Switzerland.

Grünfeld, L., M. Wulf, M. C. Rillig, A. Manntschke and S. D. Veresoglou. 2020. Neighbors of arbuscular-mycorrhiza associating trees are colonized more extensively by arbuscular mycorrhizal fungi than their conspecifics in ectomycorrhiza dominated stands. *New Phytologist* 227(1): 10–13.

Harrison, J. W. 2022. Photo of *Sanicula trifoliata* from Kentucky. Shared via iNaturalist at <https://inaturalist.ca/observations/119149108>, licensed by <https://creativecommons.org/licenses/by-nc/4.0/>

Hawkins, T. S., J. M. Baskin and C. C. Baskin. 2007. Seed Morphology, germination phenology, and capacity to form a seed bank in six herbaceous layer Apiaceae species of the eastern deciduous forest. *Castanea* 72(1): 8–14.

Hilty, J. 2020. Illinois Wildflowers. Accessed April 10, 2023 at https://www.illinoiswildflowers.info/woodland/plants/cn_blsnakeroot.htm
https://www.illinoiswildflowers.info/woodland/plants/cm_blsnakeroot.htm
https://www.illinoiswildflowers.info/flower_insects/plants/cn_blsnakeroot.htm

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

ITIS (Integrated Taxonomic Information System). Accessed December 15, 2022 at <http://www.itis.gov>

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)].

Klemow, K. M. and D. J. Raynal. 1985. Demography of two facultative biennial plant species in an unproductive habitat. *Journal of Ecology* 73(1): 147–167.

LeGrand, H., B. Sorrie and T. Howard. 2023. Account for Large-fruit Black-snakeroot – *Sanicula trifoliata* (Vascular Plants of North Carolina. North Carolina Biodiversity Project and North Carolina State Parks, Raleigh, NC. Accessed April 10, 2023 at https://auth1.dpr.ncparks.gov/flora/species_account.php

Mid-Atlantic Herbaria. 2022. Accessed on December 15, 2022 at <https://midatlanticherbaria.org/portal/index.php>.

MNDNR (Minnesota Department of Natural Resources). 2023. *Sanicula trifoliata*. Accessed February 24, 2023 at <https://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDAPI1Z0L0#:~:text=Sanicula%20trifoliata%20is%20a%20biennial,and%20palmately%203%2Dparted%20blades.>

MNHP (Maryland Natural Heritage Program). 2021. Rare, Threatened, and Endangered Plants of Maryland. C. Frye (ed.). Maryland Department of Natural Resources, Annapolis, MD. DNR 03-030321-270. 231 pp.

Native Plant Trust. 2023. *Sanicula trifoliata* – Large-fruited sanicle. Accessed April 2, 2023 at <https://gobotany.nativeplanttrust.org/species/sanicula/trifoliata/>

NatureServe. 2022. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed December 15, 2022 at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.134398/Sanicula_trifoliata

Newcomb, L. 1977. Newcomb's Wildflower Guide. Little, Brown and Company, Boston, MA. 490 pp.

NJDEP (New Jersey Department of Environmental Protection). 2020. Climate Change in New Jersey: Trends in Temperature, Precipitation, Extreme Events, and Sea Level Rise. Environmental Trends Report, Office of Science and Research. Accessed August 19, 2022 at <https://nj.gov/dep/dsr/trends/Climate%20Change.pdf>

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.

Olivera, A. M. and D. M. Hix. 1998. Influence of aspect and stand age on ground flora of southeastern Ohio forest ecosystems. *Plant Ecology* 139:177–187.

POWO. 2022. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed December 15, 2022 at <http://www.plantsoftheworldonline.org/>

Pryer, K. M. and L. R. Phillippe. 1989. A synopsis of the genus *Sanicula* (Apiaceae) in eastern Canada. *Canadian Journal of Botany* 67:694–707.

Robertson, C. 1929. *Flowers and Insects*. The Science Press, Lancaster, PA.

Strausbaugh, P. D. and E. L. Core. 1978. *Flora of West Virginia*. Seneca Books, Inc., Morgantown, WV. 1079 pp.

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 Forest Service (U. S. Dept. of Agriculture, Forest Service). 2002. *Sanicula trifoliata* – Status in New England States and White Mountain National Forest. Accessed April 25, 2023 at https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5211775.pdf

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2022a. *Sanicula trifoliata* 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 *Sanicula trifoliata* (Large-fruit Black-snakeroot). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed December 15, 2022 at <http://plants.usda.gov>

Van Hemessen, Will. 2021. Photo of *Sanicula trifoliata* from Ontario. Shared via iNaturalist at <https://inaturalist.ca/observations/90656128>, licensed by <https://creativecommons.org/licenses/by-nc/4.0/>

Voelker, Vanessa. 2018. Photo of *Sanicula trifoliata* fruits from Illinois. Shared via iNaturalist at <https://inaturalist.ca/observations/9913184>, licensed by <https://creativecommons.org/licenses/by-nc/4.0/>

Walz, K. S., L. Kelly, K. Anderson and J. L. Hafstad. 2018. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservatism (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: 299–363.

Weakley, A. S. and Southeastern Flora Team. 2022. Flora of the southeastern United States. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC. 2022 pp.