Hydrophyllum canadense

Broad-leaf Waterleaf

Hydrophyllaceae

Hydrophyllum canadense courtesy Alan Cressler, Lady Bird Johnson Wildflower Center

***Hydrophyllum canadense* Rare Plant Profile**

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

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Life History

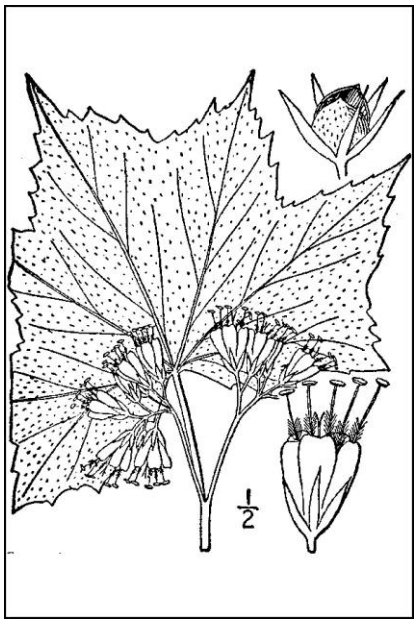
Hydrophyllum canadense (Broad-leaf Waterleaf) is a rhizomatous perennial herb. *Hydrophyllum* was traditionally part of the Hydrophyllaceae but that entire family is now included in the Boraginaceae (APG II 2003). *Hydrophyllum canadense* can reproduce clonally by means of its rhizomes, often forming large patches or monospecific stands and occasionally becoming dense enough to restrict the growth of other understory species (Cox et al. 1972, Graves and Monk 1982 & 1985, Marr and Marshall 2006). The rhizome is long and scaly, producing fleshy-fibrous roots at the internodes (Constance 1942). The roots are simple, branching up to four times. Pregitzer et al. (1997) measured the root branch internodes of *H. canadense* and reported a range of 2.9–5.2 mm.

Hydrophyllum canadense plants have both basal leaves and alternate stem leaves. The earliest leaves to emerge are basal: They may be either pinnately or palmately lobed and often have a mottled pattern of whitish, gray, or silvery spots. The stem leaves are palmate with 5–9 shallow lobes, a uniform green color, and scattered stiff hairs (trichomes) on their upper surfaces (Constance 1942, Beckmann 1979, NCCE 2024). The trichomes of *H. canadense* contain deposits of calcium, silicon, and phosphorous which strengthen and stabilize the hairs. Although the specific role of *H. canadense* trichomes was not identified, potential functions include defense against herbivores and moderation of water loss, temperature, or ultraviolet radiation (Mustafa et al. 2018).



Left: Paul Abell, 2019. Center: B. Whitely, 2021. Right: Courtesy Stephanie Brundage, Lady Bird Johnson Wildflower Center.

The stems of *Hydrophyllum canadense* may range from 2–7 dm in height but according to Givnish (1982) they are usually under 5 dm. The plants typically produce two flower clusters that hang below the leaves, with each cluster containing up to 20 flowers. *H. canadense* flowers have five linear sepals and five white to purplish petals that are fused at the base, forming a bell-like shape. The stamens and styles extend well beyond the ends of the petals and long hairs are present on the filaments of the stamens. The fruits are few-seeded capsules. (See Britton and Brown 1913, Constance 1942, Fernald 1950, Westmoreland 1981, Gleason and Cronquist 1991, Marr and Marshall 2006).



Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Right: Courtesy Stephanie Brundage, Lady Bird Johnson Wildflower Center.

Hydrophyllum canadense overwinters as a rosette of basal leaves and produces numerous palmate leaves in the spring (Beckmann 1980). Flowering stems typically have two leaves whereas vegetative plants are single-leaved (Marr and Marshall 2006). Bazzaz and Bliss (1971) noted that Broad-leaf Waterleaf belongs to a suite of species that become prevalent in the herb layer as the canopy closes and the spring ephemerals fade. Such plants make a large investment in aboveground growth and reproduction early in the season and probably replace their reserves later on. *H. canadense* usually blooms in June or July, although it can begin as early as May, and mature fruits may present from late July through September (Bard 1949, Morgan 1971, Westmoreland 1981, Hough 1983, Marr and Marshall 2006, Rhoads and Block 2007, Weakley et al. 2022). Annual clonal growth occurs over a distance that roughly equals plant height (Singleton et al. 2001). The foliage dies back with the killing frosts, which generally occur in late October or November (Twomey 1945, Marr and Marshall 2006). Taylor (1915) estimated that the growing season of *H. canadense* lasted for about 176 days.

Pollinator Dynamics

Hydrophyllum canadense flowers have modified tissue inside the lower part of the petals that forms elongate parallel scales with overlapping bases and a gap at the top. Nectary glands are situated at the base of the ovary adjacent to the modifications, which may simultaneously serve as nectar guides and protect the nectar from flower visitors that do not provide pollination services (Jeiter and Weigend 2018). The hairs on the filaments of *Hydrophyllum* flowers may also act as a barrier to some insects while slowing down nectar evaporation (Holm 2014).

Hydrophyllum flowers are visited by a wide variety of bees, wasps, flies, butterflies, and skippers (Robertson 1929, Hilty 2020). However, bees are the most frequent visitors and probably the most important pollinators (Beckmann 1979, Marr and Marshall 2006, Holm 2014). The

Waterleaf Mining Bee, *Andrena geranii*, is a specialist pollinator of *Hydrophyllum* species (Fowler 2016). Beckmann (1979) observed that pollinator activity was lower on *H. canadense* than on other members of the genus, perhaps because the flowers clusters were somewhat concealed by the leaves.

In *Hydrophyllum* flowers the anthers mature before the stigmas become receptive, increasing the likelihood of cross-fertilization, but most species (including *H. canadense*) are also self-compatible (Marr and Marshall 2006, Holm 2014). However, they appear to lack a mechanism for self-fertilization so it probably occurs infrequently in nature (Beckman 1979).

Seed Dispersal and Establishment

Hydrophyllum canadense flowers have four ovules but the capsules usually contain only one or two seeds. *H. canadense* seeds are light to dark brown and typically 3–4 mm in diameter, although they can be highly variable in size. The capsules release the seeds during the fall (Constance 1942, Marr and Marshall 2006). Since the seeds lack specialized dispersal mechanisms they rely primarily on gravity and are likely to end up within a meter of the parent plants (Singleton et al. 2001, Farnsworth and Ogurcak 2008). Although no descriptions of long-distance dispersal strategies were found for *H. canadense*, the propagules of plants situated along waterways might sometimes be transported by water.

Hydrophyllum seeds are dormant at maturity and require particular environmental triggers in order to germinate (Gamboa-deBuen et al. 2008). Baskin and Baskin (1983) studied the germination process in a related perennial waterleaf, *H. macrophyllum*. In that species root dormancy is broken by high temperatures and the roots emerge in late autumn. Once the roots have established a period of cold is needed to break shoot dormancy so the first shoots appear during late winter or early spring. The authors also noted that germination of some *H. macrophyllum* seeds was delayed for up to three years. According to Leopold (2005), the seeds of *Hydrophyllum canadense* require a three-month period of cold stratification.

Habitat

Hydrophyllum canadense can grow successfully in a variety of light conditions ranging from partial sun to deep shade (Leopold 2005, NCCE 2024) and Szakacs et al. (2022) classified the species as a generalist in terms of shade tolerance. The large leaves help the plants to trap light in settings where it is limited (Bazzaz and Bliss 1971, Morgan 1971). McDougall and Penfound (1928) noticed morphological differences in the leaves on *H. canadense* plants that were growing in sunlit or densely shaded locations—those in shaded sites were thinner, had a proportionately larger surface area, and contained more spongy tissue. The shade leaves of *H. canadense* have a simple structure that minimizes the resource investment necessary for their construction, including a single layer of photosynthetic cells, while the spongy tissue inside the leaves scatters light and facilitates greater absorbance (De Lucia et al. 1991 and 1996).

Hydrophyllum canadense generally occurs in forested sites with moist, nutrient rich soils. It may be found along streambanks, in ravines, or on rocky wooded slopes (Fairbrothers and Hough 1973, Coddington and Field 1978, Westmoreland 1981, Hough 1983, Rhoads an Block 2007, Elliott et al. 2014, Weakley et al. 2022). Many of New Jersey's occurrences have been located in alluvial floodplains (NJNHP 2024). *H. canadense* has been documented in second-growth forests, including sites that were formerly logged (Welch et al. 2007, Bunn et al. 2010), and Thompson (1980) noted that the species could establish on both fallen logs and in pits that were created by fallen trees. Soil pH may vary. In New York the soil pH associated with *H. canadense* populations ranged from 5.93–6.01 (Bard 1949), values of 5.9–6.8 were recorded at sites where the species was growing in Indiana (Beals and Cope 1964), and 6.6 was characteristic of Georgia communities over a marble substrate (Graves and Monk 1985). *H. canadense* has also been found in areas with calcareous bedrock (Norton 1898, Ramstetter and Popp 2001) which are likely to have more alkaline soils.

Reported associates at a Vermont site included ferns such as *Dryopteris goldiana* and *Homalosorus pycnocarpos* (Churchill 1905). In an Illinois Sugar Maple (*Acer saccharum*) forest, *Hydrophyllum canadense* was one of the dominant species in the herb layer, along with *Asarum canadense*, *Laportea canadensis*, and *H. appendiculatum*. However, *H. canadense* was not closely associated with the other dominant herbs and in fact negative associations with *A. canadense* and *H. appendiculatum* were reported (Cox et al. 1972).

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). *Hydrophyllum canadense* has more than one wetland indicator status within the state. In the Atlantic and Gulf Coastal Plain region it is a facultative wetland species, meaning that it usually occurs in wetlands, but in the Eastern Mountains and Piedmont it is a facultative upland species, meaning that it usually occurs in nonwetlands. In the Northcentral and Northeast region it is facultative, meaning that it is equally likely to occur in wetlands or nonwetlands (U. S. Army Corps of Engineers 2020).

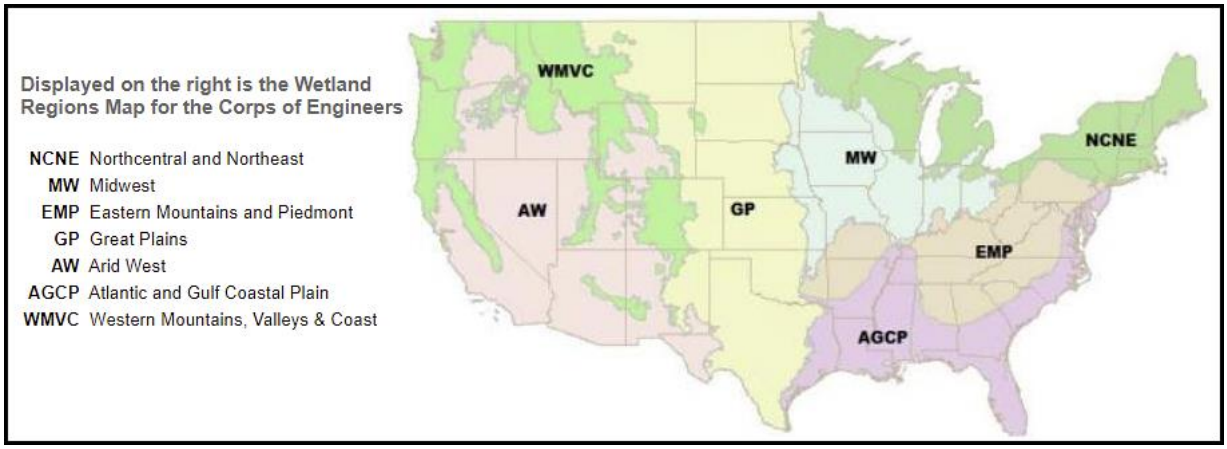


Figure 1. Mainland U. S. wetland regions, adapted from U. S. Army Corps of Engineers (2020).

USDA Plants Code (USDA, NRCS 2024b)

HYCA3

Coefficient of Conservancy (Walz et al. 2020)

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 *Hydrophyllum canadense* is restricted to the eastern United States and Canada (POWO 2024). The map in Figure 2 depicts the extent of the species in the North America.

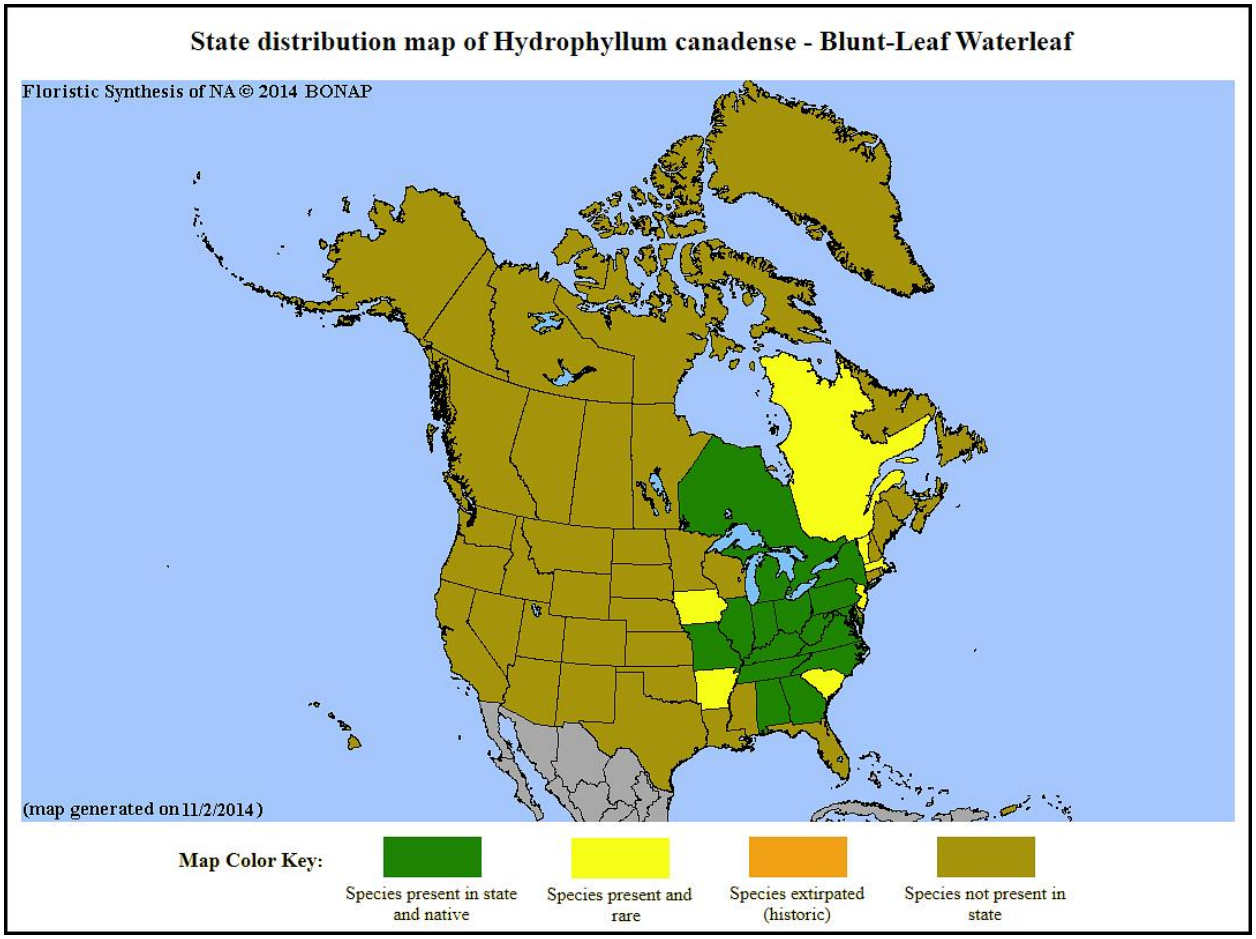


Figure 2. Distribution of H. canadense in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2024b) shows records of *Hydrophyllum canadense* in two New Jersey counties: Hunterdon and Warren (Figure 3). The waterleaf is still thought to be extant in both counties.

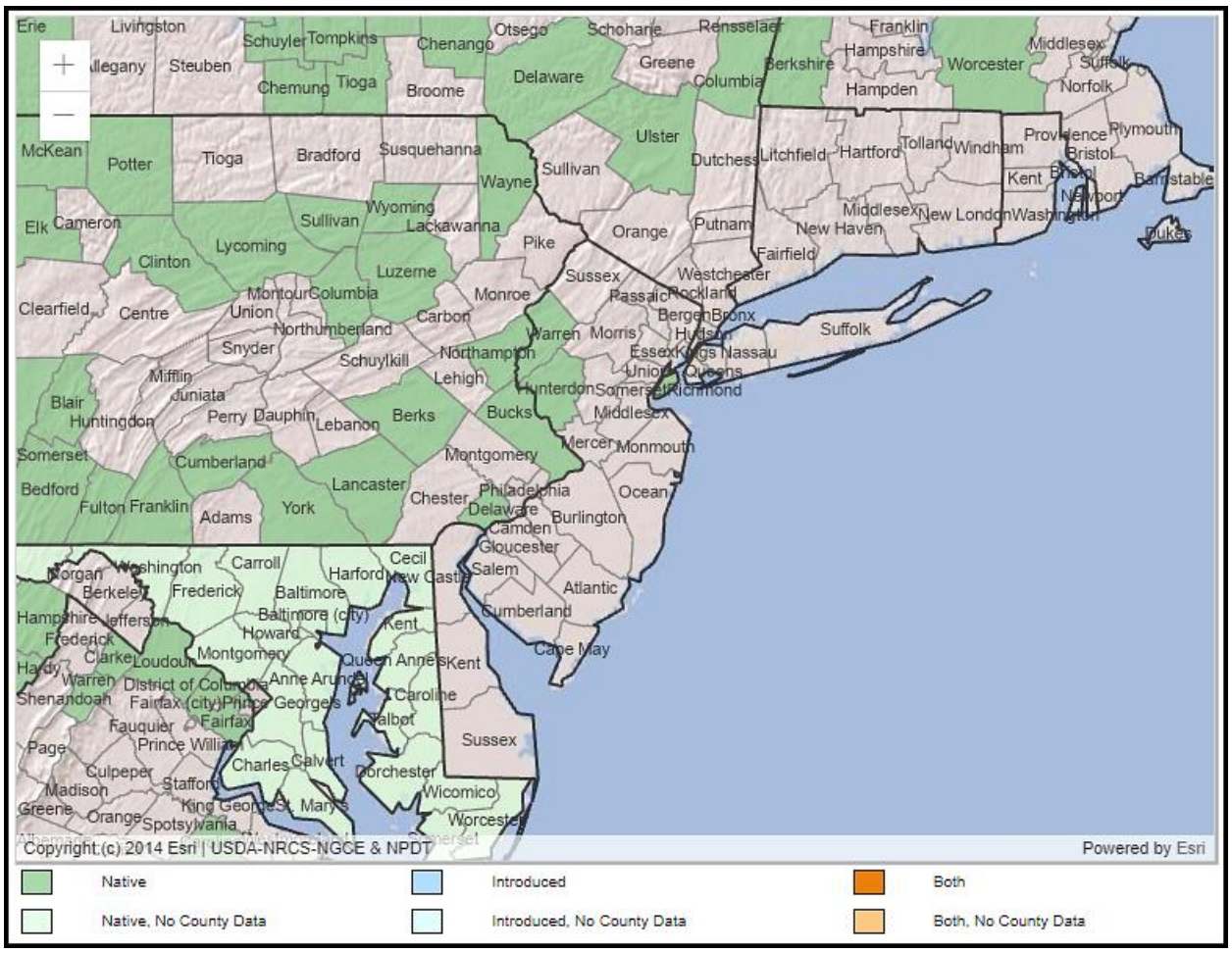


Figure 3. County records of H. canadense in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Hydrophyllum canadense 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 Broad-leaf Waterleaf throughout its range. *H. canadense* is vulnerable (moderate risk of extinction) in one state, imperiled (high risk of extinction) in one state, and critically imperiled (very high risk of extinction) in three states and one province. It is secure, apparently secure, or unranked in other districts where it occurs.

New Jersey is one of the states where *Hydrophyllum canadense* is critically imperiled (NJNHP 2024). 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. *H. canadense* 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 the waterleaf 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).

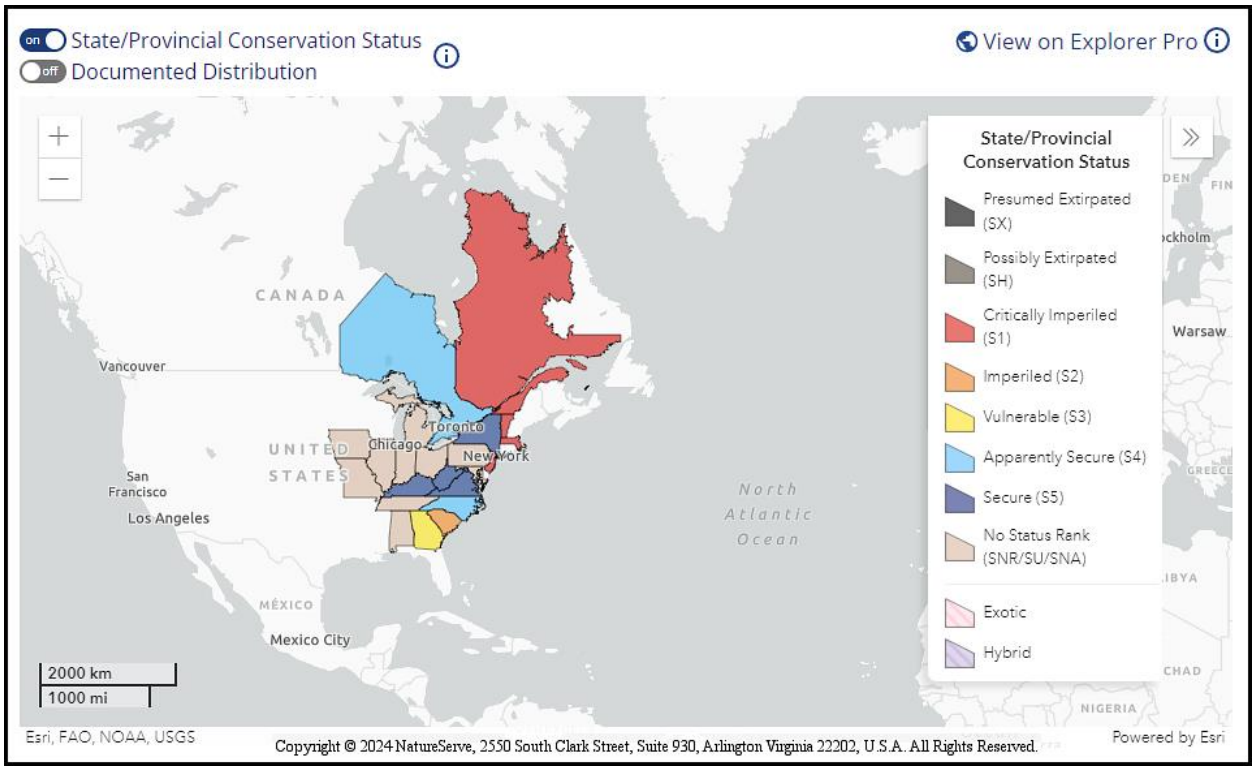


Figure 4. Conservation status of H. canadense in North America (NatureServe 2024).

Hydrophyllum canadense was known from a single site in Warren County during the early 1900s (Taylor 1915). The species was ranked as endangered by Fairbrothers and Hough (1973) because it was only extant in one location, and although a few other occurrences were subsequently documented Hough (1983) only showed records from Warren County and noted that *H. canadense* had always been rare where it was found in the state. Since then, Broad-leaf Waterleaf has also been discovered in Hunterdon County. Nine populations are presently ranked as extant but a number of those only contain a small number of plants or are facing significant threats (NJNHP 2024).

Threats

New Jersey's populations of *Hydrophyllum canadense* are jeopardized by habitat destruction, herbivory, and the spread of non-indigenous invasive plants. Similar concerns have been noted in New England (Ramstetter and Popp 2001). A variety of habitat quality issues were reported as concerns for occurrences in New Jersey depending on their locations but examples included

the deposition of trash and woody debris by floodwaters, damage during the course of roadside maintenance, and the expansion of a lawn into a former woodland community.

The proliferation of exotic flora is a well-documented and ever-growing threat to rare plant populations throughout New Jersey (NJDSR 2021). Highly invasive plant species identified as threats to *Hydrophyllum canadense* in the state have included *Alliaria petiolata, Anthriscus sylvestris*, *Artemisia vulgaris*, *Berberis thunbergii, Cardamine impatiens, Celastrus orbiculatus, Humulus japonicus, Lonicera japonica, Microstegium vimineum, Reynoutria japonica, Rosa multiflora,* and *Rubus phoenicolasius*. At some locations the invasive plants were noted as an emerging threat but at other locations they were already overtaking the waterleaf populations (NJNHP 2024). A number of those species have also been cited as threats to *H. canadense* populations in New England, along with others such as *Hesperis matronalis* (Ramstetter and Popp 2001).

At one of New Jersey's smallest occurrences of *Hydrophyllum canadense* both the flowering stems and leaves had been browsed by deer (NJNHP 2024). A study of the impacts of browsing by White-tailed Deer (*Odocoileus virginianus*) on selected forest plants indicated that a related species (*Hydrophyllum virginianum*) was somewhat tolerant of herbivory because it could regenerate from its rhizomes. Nevertheless, browsing studies of other understory herbs have shown a correlation between reduction of leaf area during the growing season and a decrease in flowering the following year (Augustine and de Calesta 2003). When Marr and Marshall (2006) investigated the effects of fungal pathogens on *H. canadense* and two other *Hydrophyllum* species, deer herbivory reduced the sample sizes of all three types of waterleaf. Extensive herbivore damage to *H. canadense* plants in New England apparently resulted from something other than deer and may have been caused by insects, slugs, or rodents (Ramstetter and Popp 2001).

Hydrophyllum canadense plants are also susceptible to wilt, and fungi identified by Marr and Marshall (2006) as the possible agents included species of *Fusarium*, *Rhizoctonia*, and *Pythium*. Infected *H. canadense* plants appeared healthy during the early spring months but exhibited visible symptoms of wilt at the beginning of the flowering period. Although some of the flowers on affected plants continued to develop many did not complete the cycle and those that did fruit produced fewer and smaller seeds.

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Hydrophyllum canadense* 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 *H. canadense* was assessed as Moderately Vulnerable, meaning that it is likely to show some decrease in abundance or range extent in New Jersey by 2050. Limited information may have resulted in miscalculating the significance of certain risk factors. For example, while *Hydrophyllum* species rely on

environmental cues to break dormancy the specific range of temperatures required for seed stratification or germination in *H. canadense* are not known.

As the climate continues to warm plants in New Jersey are increasingly exposed to higher temperatures, and shifting precipitation patterns are increasing the frequency and intensity of both droughts and floods (Hill et al. 2020). Certain *H. canadense* populations have already been effected by exposure to more frequent and severe flooding that has resulted in scouring, erosion, or the deposition of silt and debris (NJNHP 2024). Some fungal infections may be exacerbated by a net increase in annual rainfall, while plants that are already affected by wilt could be more susceptible to drought stress.

Invasive plants have already been identified as a significant problem for a number of New Jersey's *Hydrophyllum canadense* populations, and that threat is likely to increase as a result of climate change. Bellard et al. (2013) identified the northeastern United States as a probable hotspot for new invasions by nonnative flora, and other evaluations have projected that a number of exotic plants which have already gained a foothold in the region are likely to become more abundant (Dukes et al. 2009, Coville et al. 2021, O'Uhuru 2022). Salva and Bradley (2023) recently identified more than a dozen new range-shifting species that could have significant detrimental impacts on New Jersey's plant communities by 2050.

Management Summary and Recommendations

Recent monitoring of two New Jersey *Hydrophyllum canadense* populations revealed notable declines as a result of competition with non-native plant species. A number of other occurrences are due for updated status assessments, particularly two that have never been fully evaluated and one that has not been visited since 1989. Past monitoring records for *Hydrophyllum canadense* populations suggest that proactive management is likely to be needed in order to maintain the species' presence in the state.

Site-specific interventions may be required to protect selected populations from herbivory or to limit human activities that directly damage *H. canadense* plants, but control of invasive flora is the primary issue for the majority of extant occurrences (NJNHP 2024). Prescribed burns are often used as a tool for managing competition or invasive species but that is not recommended at sites where *Hydrophyllum canadense* occurs. The use of controlled burns in deciduous forests was evaluated by Wilder (2011), who found that *H. canadense* was negatively influenced by fire and populations decreased in density at burned sites. The exotic plants noted as posing the greatest threats to Broad-leaf Waterleaf differ from one site to the next so a variety of management strategies may be needed depending on the local topography and problem species.

Initiatives underway to protect *Hydrophyllum canadense* in New England include the collection and long-term storage of seeds and seed germination experiments (Ramstetter and Popp 2001). There are several areas where additional research on *H. canadense* could provide useful information for conservation planning. Suggested topics for further study include the relative importance of sexual vs. clonal reproduction for maintaining populations, possible mechanisms for long-distance dispersal, and potentially beneficial fungal associations.

Synonyms

The accepted botanical name of the species is *Hydrophyllum canadense* L. Orthographic variants, synonyms, and common names are listed below (ITIS 2024, POWO 2024, USDA NRCS 2024b).

Botanical Synonyms	Common Names
Hydrophyllum acerifolium Salisb.	Broad-leaf Waterleaf
Hydrophyllum lobatum Stokes	Bluntleaf Waterleaf
	Canada Waterleaf
	Large Waterleaf
	Mapleleaf Waterleaf

References

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