

Hydrastis canadensis

Golden Seal

Ranunculaceae



Hydrastis canadensis by Peter M. Dziuk, 2007

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Hydrastis canadensis Rare Plant Profile

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

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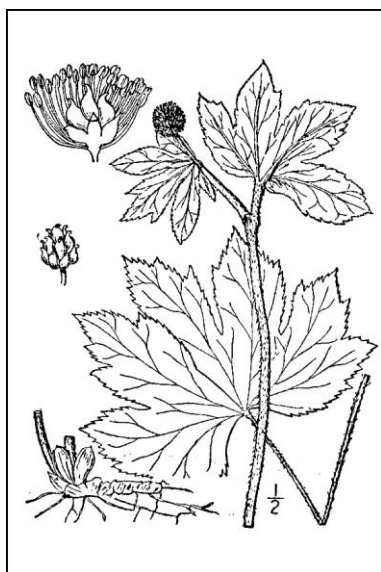
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Life History

Hydrastis canadensis (Golden Seal) is a rhizomatous perennial woodland herb. *Hydrastis* is a monophyletic genus that has traditionally been placed in the Ranunculaceae. However it differs from most members of the buttercup family in several respects and has a number of features that more closely resemble those of species in the Berberidaceae. Some taxonomists now assign *Hydrastis* to its own family (Hydrastidaceae) but the change has not been universally adopted (Keener 1993, Thorne 2000, Kartesz 2015, Ford 2020, Weakley et al. 2024).

Hydrastis canadensis is capable of vigorous clonal growth. The plants have a fleshy, knotted rhizome and numerous fibrous rootlets. New stems (ramets) can develop from the branching rhizomes and also via adventitious buds that form along the rootlets (Bowers 1891, Millspaugh 1892, Albrecht and McCarthy 2006). Clonal colonies can range in size from several individuals to thousands of plants (McGraw et al. 2003, Tait 2006). Bowers (1891) observed that a single plant could spread to occupy an area up to two meters in diameter over a period of 8–10 years. Older *H. canadensis* rhizomes decay over time but they can persist for several decades (COSEWIC 2019).



Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Center: Charles F. Millspaugh, 1892. Right: Peter M. Dziuk, 2007.

Mature, reproductive *Hydrastis* plants have erect, unbranched, pubescent stems that are 15–50 dm tall. The leaves are palmately lobed and toothed. Long-stalked basal leaves appear first but wither early so at flowering time two leaves are usually present on the stem: The lower one is larger and has a distinct stalk while the uppermost one is sessile. A solitary flower is produced on a 5–38 mm long peduncle that arises from the base of the upper leaf. *H. canadensis* flowers have three sepals that fall off at blooming time and no petals, but each globose flower head has 5–15 pistils and 50–75 showy white stamens 4–8 mm in length. The berry-like fruits of *H. canadensis* are closely aggregated clusters of spirally arranged carpels that turn crimson when upon ripening. (See Bowers 1891, Millspaugh 1892, Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1991, Rhoads and Block 2007, Ford 2020).



Peter M. Dziuk, 2007.



Chris Morris, 2006.

Hydrastis canadensis generally flowers in the spring and produces mature fruit during the summer but timing may vary with latitude or weather conditions. The plants usually bloom during April or May and fruit in July (Millspaugh 1892) but flowering can extend into early June (Rhoads and Block 2007) and fruits can be present as early as May (Weakley et al. 2024) or as late as August (Hus 1907). *H. canadensis* populations in the central Appalachian region flower from mid- to late April (McGraw et al. 2003) while those in Ontario bloom in early May (Sinclair 2002). Records from Ohio indicated that flowering took place between April 20 and May 10 and fruits were present from mid-June through the end of July (Eichenberger and Parker 1976, Philhower-Gillen 2014). Plants in one New Jersey population were flowering on April 29, 2011 but the following year only a few were still in bloom by April 24 and many were already developing fruit. Immature and mature fruits have been observed in the state early in June (NJNHP 2024).

Hydrastis canadensis is similar to other shade-tolerant forest herbs, which tend to be long-lived and slow growing (Bierzychudek 1982). Golden Seal plants take several years to reach reproductive maturity, passing through several stages along the way. Seedlings do not resemble the mature plants: They have a pair of round, bright green, long-stemmed cotyledons that usually serve as the sole photosynthetic organs for the first growing season, disappearing at the end of the summer. During the second stage—which typically lasts for a year or two—a single palmately-lobed basal leaf is produced, while flowering stalks usually develop in the third or fourth year (Bowers 1891, Hus 1907). Plants that have flowered may revert to the previous stage, producing a single sterile leaf the following year, and stems that develop clonally from rhizomes or root buds can also resemble second-stage juvenile plants. The majority of ramets in any given population are likely to be nonflowering: Several size classes of sterile plants are usually present, and it appears that the plants must reach a critical size to reproduce sexually or vegetatively (Tait 2006, Christensen and Gorchov 2010). Eichenberger and Parker (1976) observed that some *H. canadensis* plants produced flowers that never opened.

Hydrastis canadensis flowers begin to develop during the previous season and winter over as buds (Bowers 1891). As the Golden Seal plants emerge in April the leaves unfold to reveal fully formed flowers. Leaf expansion is greatest after blooming and prior to fruit development, and once the fruits have matured the greatest investment is made in growth of belowground organs. *H. canadensis* plants generally die back late in the growing season or after the first killing frost (Eichenberger and Parker 1976).

The bright yellow rhizomes of *Hydrastis canadensis* have long been valued both for the production of dyes and for their medicinal properties (Barton 1818, Millspaugh 1892). Several powerful alkaloids are present in the roots and Indigenous Americans utilized them to treat a variety of conditions. Golden Seal is still one of the most widely used herbal medicines in the United States and extensive collection of the plants in the wild has spawned a great deal of interest in cultivation of the species for commercial purposes (Robbins 1999, Douglas et al. 2013, Inoue et al. 2013, Ford 2020, Weakley et al. 2024). Clinical studies using isolated alkaloids extracted from *H. canadensis* roots have substantiated a number of the reported therapeutic benefits but concerns have been raised regarding the use of the rhizomes in raw or powdered form. Interactions between multiple compounds present in the plant have not been thoroughly researched, there is some evidence that Golden Seal can inhibit the action of other prescription drugs, and additional potentially harmful effects have been reported (Mahady et al. 2003, Pengelly et al. 2012, Mandal et al. 2020). When *H. canadensis* is sold as a treatment or dietary supplement alternative species that are less costly and more readily available have sometimes been substituted by unscrupulous suppliers, both historically and recently. Ill effects resulting from the dilution or substitution of ingredients can range from the reduction of therapeutic value to toxicity (Tims 2016).

Pollinator Dynamics

The flowers of *Hydrastis canadensis* remain open for five or six days (Bowers 1891) and during that time they are visited by an assortment of generalist bees and flies. The primary pollinators observed during an Ontario study were small bees (*Dialictus* and *Lasioglossum* species). Other floral visitors included some larger bees (*Andrena*, *Bombus*, *Augochlora*) and syrphid flies in the genus *Eupeodes* (Sinclair et al. 2000).

Hydrastis canadensis is self-compatible so it does not matter if the plants are fertilized with their own pollen or pollen from another ramet on the same clone. Sanders (2004a, 2004b) found that fruit set did not significantly differ between self-pollinated or outcrossed plants. Observations of natural populations in Ohio indicated that 55–73% of the *H. canadensis* plants that flowered successfully produced fruit (Christensen and Gorchov 2010). A genetic diversity study spanning four states documented higher levels of genetic variation within *H. canadensis* populations than between sites, indicating that extant colonies are maintained by both sexual and vegetative reproduction (Inoue et al. 2013).

Seed Dispersal and Establishment

Each of the carpels of a *Hydrastis canadensis* flower can produce one or two shiny, black, ovoid seeds that are about 3 mm long (Hus 1907). The average number of seeds per fruit reported following a study of Ohio populations ranged from 6.4–14.7 and seed viability ranged from 58–69% (Christensen and Gorchov 2010). The bright red fruits sitting atop the plants are attractive to birds, which are frequently reported as their primary consumers (Bowers 1891, Hus 1907, Eichenberger and Parker 1976, Sinclair et al. 2000). Philhower-Gillen (2014) used scouting cameras to document potential dispersers of forest herbs and found that *H. canadensis* fruits were often removed by turkeys and songbirds and occasionally by mice. Birds are likely to play a significant role in the establishment of populations at new locations (Albrecht 2006). Bowers (1891) remarked that ripe Golden Seal fruits were easily detached and Sanders (2004a) noted that she had repeatedly seen *H. canadensis* fruits on the ground near the parent plants, so those that are not eaten by vertebrates are probably gravity-dispersed. Arthropod activity observed by Redles (1926) included arachnids (Daddy Longlegs) feeding on fallen berries and ants carrying mud to the fruits and burying them where they had landed.

Hydrastis canadensis seeds that are dispersed during the summer are most likely to germinate during April or early May of the following spring (Bowers 1891, Hus 1907, Baskin and Baskin 1988). The propagules of *H. canadensis* do not persist in the soil as long as those of other typical forest herbs: Any seed bank the species may form is generally limited to two annual cycles (Albrecht 2006, Albrecht and McCarthy 2011). That may be because the seeds require consistently moist soil—they are particularly sensitive to desiccation and rapidly lose viability upon drying. Because they fare poorly in dry storage, the planting of fresh seed is recommended for propagation of *H. canadensis* (Hus 1907, Albrecht 2006, Diboll 2018).

Golden Seal seeds are dormant at the time of dispersal and require alternating periods of warm and cold stratification in order to germinate. In nature that is accomplished by the changing of the seasons but in a laboratory setting germination can be triggered by sequential periods of exposure to autumn, winter, and spring temperatures. Leaf litter depth appears to have an important effect on seedling emergence and establishment but optimal amounts may vary depending on the site. A deep litter layer can inhibit germination and seedling survival but in some settings the absence of any litter layer may allow the soil to become too dry for the seeds or juvenile plants (Albrecht 2006). Albrecht suggested that mature *H. canadensis* plants might be able to withstand a wider range of conditions than those tolerated by the seedlings.

Sanders (2004a) documented the presence of endomycorrhizal fungi in *Hydrastis canadensis* roots but there is no evidence that fungal associates are required for seedling establishment. Golden Seal was characterized as a non-symbiotic species by Farnsworth and Ogurcak (2008). Perennial forest herbs are often facultatively mycorrhizal depending on the availability of nutrients or water (Boerner 1986, DeMars and Boerner 1995, Watson et al. 2001, Rožek et al. 2019).

Low rates of establishment from seed are often reported for *Hydrastis canadensis* and the species is thought to depend primarily on clonal reproduction to maintain populations (Sinclair 2002, Sanders 2004a, Albrecht 2006). Christensen and Gorchov (2010) found seedling recruitment to

be more common than previously suggested but they determined that vegetative reproduction was still the most important mechanism for population growth. As noted earlier, the results of the genetic evaluation conducted by Inoue et al. (2013) indicated that both seeds and vegetative reproduction contribute to the development of *H. canadensis* populations. However, without a genetic assessment or a long-term study of seedling establishment it would be nearly impossible to determine the relative importance of sexual reproduction in any given population. The distance between an established plant and a new clonal offshoot can exceed 60 cm, and other stems are sometimes present between 'parent' and 'daughter' ramets (Christensen and Gorchoff 2010). Seed dispersals by both gravity and birds—which were noted by Philhower-Gillen (2014) to consume an entire cluster of carpels as a unit—are likely to result in clumped distributions of Golden Seal plants comparable to those formed by clonal growth (Eichenberger and Parker 1976).

Habitat

Throughout its range, *Hydrastis canadensis* typically grows in rich, mesic deciduous forests at elevations ranging from 50–1200 meters above sea level (Bowers 1891, Millspaugh 1892, Reveal and Broome 1981, Schmalzer et al. 1985, Henson 2001, Rhoads and Block 2007, Ruch et al. 2008, Zuiderveen et al. 2019, Ford 2020, Weakley et al. 2024). The plants require a moist but well-drained substrate, and they have been found on loamy soils, decaying leaves, or rotting logs (Bowers 1891, McAvoy 2000, Henson 2001, Leopold 2005). Soil pH recorded in Golden Seal habitats in New York ranged from 5.9–7.2 with an overall mean of 6.6 (Tait 2006), although experimental work by Davis (1996) indicated that optimal root development occurred at pH 5.5–6.5.

Suitable forested habitats for *Hydrastis canadensis* can be found in a variety of locations. The species has a relatively broad ecological niche and does not display a strong association with abiotic environmental variables such as slope, aspect, or distance to water (Sanders and McGraw 2005a, Tait 2006). Canopy composition varies from one site to the next: Dominant trees may include *Acer saccharum*, *Carpinus caroliniana*, *Carya* spp., *Crataegus* spp., *Fagus grandifolia*, *Fraxinus* spp., *Juglans nigra*, *Liriodendron tulipifera*, *Ostrya virginiana*, *Quercus* spp. or *Tilia americana* (Schmalzer et al. 1985, Henson 2001, Tait 2006, Zuiderveen et al. 2019, NJNHP 2024). *Arisaema triphyllum*, *Asarum canadense*, *Dryopteris marginalis*, *Hepatica americana*, *Maianthemum* spp., *Podophyllum peltatum*, and *Sanguinaria canadensis* are characteristic associates on the forest floor, and species like *Ageratina altissima*, *Anemone quinquefolia*, *Aralia nudicaulis*, *Botrypus virginianus*, *Caulophyllum thalictroides*, *Circaea canadensis*, *Claytonia virginica*, *Erythronium americanum*, *Panax quinquefolius*, or *Viola* spp. may also be present (Schmalzer et al. 1985, McAvoy 2000, Tait 2006, Zuiderveen et al. 2019). Although relatively little genetic variation has been found between different populations of *Hydrastis canadensis* (Torgerson 2012, Inoue et al. 2013) the species exhibits some morphological plasticity in response to local site conditions (Bowers 1891, Sanders and McGraw 2005b).

Hydrastis canadensis has often been found in deeply shaded habitats and Weakley et al. (2024) classified it as an obligate shade species. However Leopold (2005) indicated that the plants can be maintained in shade or partial sun. Based on a literature review and interviews with Golden

Seal cultivators, Henson (2001) concluded that 70–87% shade was optimal for growth, although a range of 30–90% shade has been reported for natural populations. Some researchers have reported a strong affiliation with interior forests and closed canopies (Eichenberger and Parker 1976, Tait 2006) but others have found a significant association with sites along paths and edges (Sinclair and Catling 2000). Millspaugh (1892) noted that *H. canadensis* could be situated in forest interiors or along woodland edges.

Although *Hydrastis canadensis* is mainly associated with stable, mature forests it is possible that the species could benefit from certain types of disruption on a periodic basis. Studies in Ontario found that plant growth and sexual reproduction was enhanced by small-scale soil disturbances comparable to those that would result from treefalls while the expansion of populations in undisturbed sites was minimal and did not significantly differ from equilibrium (Sinclair and Catling 2004, Sinclair et al. 2005). Increases in the vegetative spread of Golden Seal have also been reported following controlled burns (Rock 2000, Sanders 2004a) or canopy disturbances from activities like logging (Weakley et al. 2024).

Wetland Indicator Status

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

USDA Plants Code (USDA, NRCS 2024b)

HYCA

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 *Hydrastis canadensis* is restricted the eastern and central United States and Canada (POWO 2024). The map in Figure 1 depicts the extent of the species in North America.

The USDA PLANTS Database (2024b) shows records of *Hydrastis canadensis* in four New Jersey counties: Camden, Mercer, Sussex, and Warren (Figure 2). There is apparently also a specimen from Bergen County (Mid-Atlantic Herbaria 2024). The data include historic observations and do not reflect the current distribution of the species.

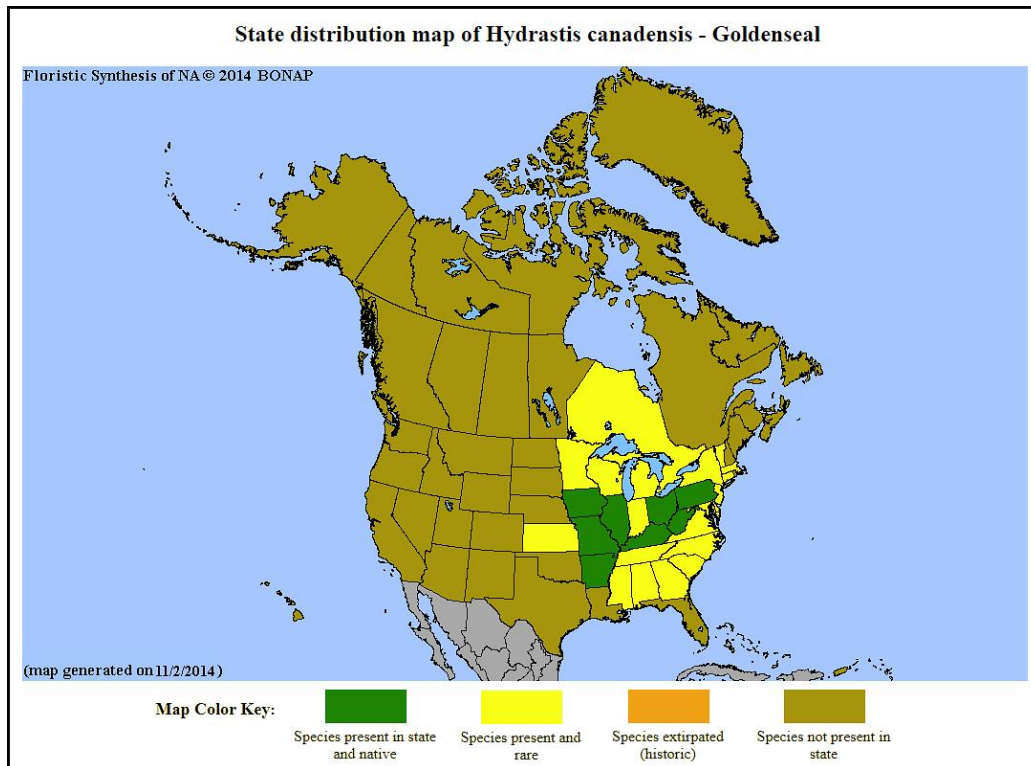


Figure 1. Distribution of *H. canadensis* in North America, adapted from BONAP (Kartesz 2015).

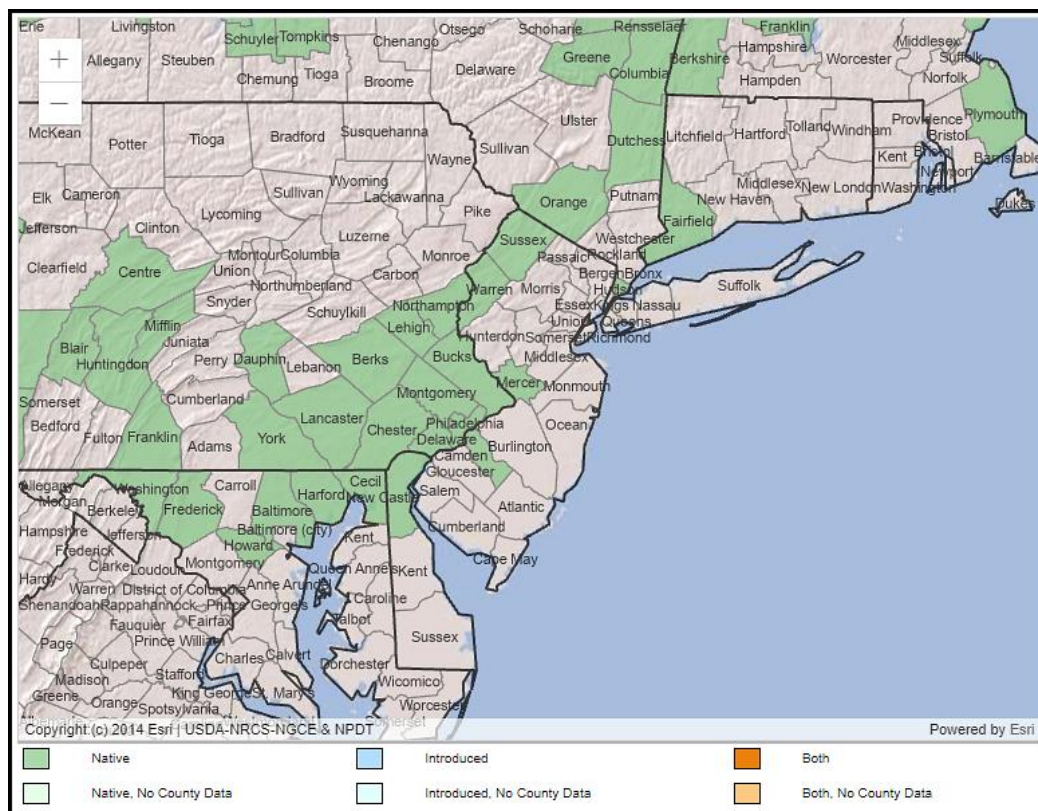


Figure 2. County records of *H. canadensis* in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Hydrastis canadensis has a global rank of G3G4, meaning there is some uncertainty as to whether it is vulnerable or apparently secure. A G3 species has a moderate risk of extinction or collapse due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors. A G4 species has a 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 result of local recent declines, threats, or other factors (NatureServe 2024).

The map below (Figure 3) illustrates the conservation status of *H. canadensis* throughout its range. Golden Seal is vulnerable (moderate risk of extinction) in six states, imperiled (high risk of extinction) in six states and one province, and critically imperiled (very high risk of extinction) in eight states. In places where *H. canadensis* populations are rare the species may still be locally abundant (McGraw et al. 2003, Rhoads and Block 2007, Prast et al. 2013, NJNHP 2024).

Hydrastis canadensis has been identified as a plant species of highest conservation priority for the North Atlantic region, which includes four Canadian provinces and twelve U. S. states. The species was assigned a rank of R2 (imperiled), signifying a high risk of regional extinction (Frances 2017). An assessment for the IUCN Red List determined that *Hydrastis canadensis* was declining throughout its range and classified it as vulnerable (Oliver 2017). *H. canadensis* was previously ranked as threatened in Canada but its status was amended to special concern in 2019 after targeted surveys documented additional occurrences (COSEWIC 2019).

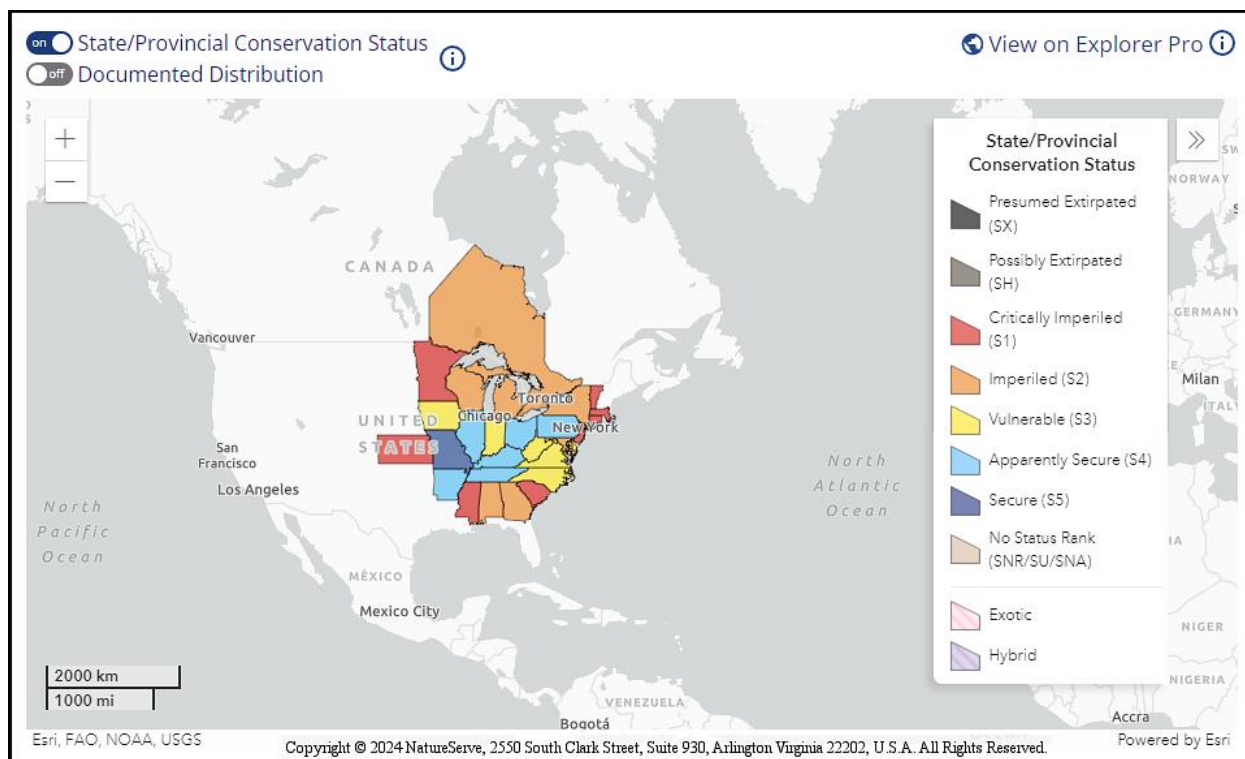


Figure 3. Conservation status of *H. canadensis* in North America (NatureServe 2024).

Hydrastis canadensis is critically imperiled (S1) in New Jersey (NJNHP 2024). The 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. canadensis* 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 Golden Seal 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).

The earliest reports of *Hydrastis canadensis* in New Jersey were from Warren and Sussex counties (Willis 1877) although Britton (1889) believed that the specimens attributed to Sussex County had been collected in New York. Taylor (1915) observed that the species was "very rare in our area" and Hough (1983) noted that no *H. canadensis* plants had been found in the state when searches were conducted during 1979 and 1980. Only one historical occurrence is tracked by the Natural Heritage Program and it was last seen in 1852. However, two new populations were documented in 2009 and in 2021 and both were fairly vigorous at the time of their discovery (NJNHP 2024).

Threats

Because *Hydrastis canadensis* is utilized so extensively as a herbal medicine, many populations throughout its range have declined as a result of wild plant harvests (Reveal and Broome 1981, Overlease 1987, Molano-Flores 2000, Mulligan and Gorchoy 2004, Leopold 2005, Rhoads and Block 2007, Jolly 2016, Ford 2020). Overcollection was already known to be taking a toll on Golden Seal during the 19th century (Bowers 1891) and that continues to be a predominant threat to the species' persistence (Oliver 2013). Even in states where *H. canadensis* has been protected by law the poaching of plants is an ongoing concern (eg. Sanders and McGraw 2005c).

As with many other upland forest plants, habitat loss is a significant problem (Leopold 2005, Ford 2020). Documented declines and ongoing threats to *Hydrastis canadensis* have been noted following the clearing of forests for development or agricultural uses (Reveal and Broome 1981, Molano-Flores 2000, Mulligan and Gorchoy 2004). Changes to its habitat caused by water management (dams, ditches) or logging practices (clearcutting, debris deposition) can make sites unsuitable for *H. canadensis* (Jolly 2016). At some locations, it is possible that extensive dieoff of ash (*Fraxinus* spp.) in the wake of the introduced Emerald Ash Borer (*Agrilus planipennis*) will cause harm comparable to that resulting from logging (ECCC 2020). Smaller scale damage from trampling or soil compaction can occur as a consequence of foot traffic or all-terrain vehicle activity (Jolly 2016).

In reviewing the threats to *Hydrastis canadensis*, Bowers (1891) said "*The grasses are its deadly enemies and ground that is trodden upon will not support it. Under such conditions it quickly perishes.*" Today, competition with invasive plants poses a growing threat to Golden Seal, although the challenges more frequently come from woody species than grasses. Tait (2006)

reported a negative correlation between *H. canadensis* stem density and the abundance of invasive plants. One of New Jersey's Golden Seal populations has visibly declined following the proliferation of plants like *Celastrus orbiculatus*, *Elaeagnus umbellata*, *Lonicera japonica*, *Rubus phoenicolasius*, and *Viburnum dilatatum* (and, yes, also a grass—*Microstegium vimineum*). When the state's second extant population was discovered in 2021, *Berberis thunbergii* and *Lonicera morrowii* were already noted to be taking over the habitat (NJNHP 2024). Similar concerns were identified in Ontario where the most problematic invasives were identified as *Alliaria petiolata*, *Ligustrum vulgare*, *Rhamnus cathartica*, *Rosa multiflora*, and multiple species of *Berberis*, *Lonicera*, and *Rubus* (Jolly 2016). The spread of *Phragmites australis* ssp. *australis* was also observed in the vicinity of two Canadian populations (ECCC 2020).

Herbivory is often dismissed as a threat to *Hydrastis canadensis* because of the abundant alkaloids produced by the plants and the frequency of toxicity in other members of the Ranunculaceae (eg. USDA 2003, Hilty 2020). However, nearly half of the stems in one Illinois population showed evidence of herbivory by White-tailed Deer (*Odocoileus virginianus*) (Frankland 2000), and Mulligan and Gorchoff (2004) believed that heavy deer browse was one of the major causes of *H. canadensis* extinction in some parts of Ohio. If deer regularly utilize *H. canadensis* as part of their diet, herbivory is likely to be a significant threat to populations in New Jersey.

Hydrastis canadensis plants seem to be more prone to fungal diseases in horticultural settings than in the wild and the species has demonstrated some resistance to common soilborne pathogens such as *Phytophthora cactorum* and *Cylindrocarpon destructans*. However, seedlings can be more susceptible to certain fungal infections than mature plants, and one fungus (*Cylindrocladium colhounii*) causes extensive damage to *H. canadensis* roots. Although seldom fatal to Golden Seal plants, *C. colhounii* can limit vegetative growth and the disease could be devastating to commercial crops (Reeleder 2003, 2004). Another fungus, *Streptobotrys streptothrix*, has been known to take a significant toll on wild *H. canadensis* populations in the Great Smoky Mountains region (Rock 2000).

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Hydrastis canadensis* 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 climatic conditions in accordance with the guidelines described by Young et al. (2016) and the state climatic computations by Ring et al. (2013). Based on available data *H. canadensis* was assessed as Moderately Vulnerable, meaning that it is likely to show some decrease in abundance or range extent in New Jersey by 2050. However, the conclusion was reached with only moderate confidence due to the sparsity of information regarding the influence of climate on some aspects of Golden Seal's life cycle.

Changing climactic conditions are causing temperatures to rise faster in New Jersey than in other parts of the northeast and the state is now experiencing a longer growing season, while shifting precipitation patterns are increasing the frequency and intensity of both droughts and floods (Hill et al. 2020). *Hydrastis canadensis* is sensitive to drought at all stages. As previously discussed, both the seeds and seedlings require moist soil in order to avoid desiccation (see Seed Dispersal and Establishment section). Mature plants are also vulnerable to dry conditions because more than 80% of their root mass is located in the top 5 cm of the soil (Douglas et al. 2013). If the ground is too hard and dry during the spring the stems may be unable to emerge, whereas a lack of moisture later in the growing season can cause a loss of foliage, premature dormancy, or mortality (Bowers 1981, Henson 2001, Christensen and Gorchov 2010).

When developing a model to predict suitable habitat for *Hydrastis canadensis* in Pennsylvania, Zuiderveen et al. (2019) found that winter temperatures played a significant role and that the likelihood of the species' occurrence declined rapidly when the mean low temperatures dropped below -2.5°C. If low winter temperatures have historically determined the northern limits of the Golden Seal's range it is possible that the species could expand its range northward as the climate warms. In other parts of its range, however, rising winter temperatures and lengthier growing seasons might disrupt the period of cold stratification required by the seeds.

Although no formal studies regarding the impact of competition on *Hydrastis canadensis* were found there is observational evidence that the proliferation of certain plants is detrimental to the species (see previous section). Invasive plants are expected to become an even greater threat to native communities in the northeast as a result of climate change (Dukes et al. 2009, Bellard et al. 2013, Salva and Bradley 2023) and their spread in New Jersey is likely to increase the pressures on *H. canadensis* as the climate continues to warm.

Management Summary and Recommendations

The most pressing current need for extant populations of *Hydrastis canadensis* in New Jersey appears to be invasive species control (NJNHP 2024). Site specific plans are needed to identify and remove the most problematic species at each location while minimizing adverse effects to the Golden Seal from strategies such as burning or herbicide application. Management activities conducted outside of the growing season are less likely to have an impact on the sexual or vegetative reproduction of *H. canadensis* but care should be taken to avoid substrate compaction and to maintain a sufficient litter layer to preserve the normal moisture levels in the soil.

Conservation strategies for *Hydrastis canadensis* throughout its range typically focus on the protection of critical habitat, the prevention of overcollection, and the development of cultivation and reintroduction programs (Molano-Flores 2000, USDA 2003, ECCC 2020). *H. canadensis* is one of more than 40,000 plant species currently listed by the Convention on International Trade in Endangered Species and Wild Fauna and Flora in order to help protect them from over-exploitation by limiting international trade (CITES 2024). Additional efforts are still needed to deter illegal collecting and to enforce existing regulations (Oliver 2013). In places where collection of *H. canadensis* is permitted, protocols can be developed to make wild harvesting more sustainable by gathering material late in the season so that the plants can store more energy

in their subterranean organs, leaving behind a sufficient amount of roots and rhizome fragments to facilitate regeneration, and allowing several years to elapse between harvests (Van der Voort et al. 2003, Sanders and McGraw 2005c, Albrecht and McCarthy 2006). Commercial propagation is encouraged as an alternative to wild harvests, particularly since the species is easy to propagate by division (Hus 1907, Leopold 2005, Pengelly et al. 2012). Recent investigations have indicated that micropropagation techniques could be used to grow *H. canadensis* in controlled settings in order to meet market demands and to help restore wild populations (Obae and West 2010).

In the Great Smoky Mountains National Park, where a fungal disease was identified as a threat to *Hydrastis canadensis* populations, a management program was initiated in 1997 to reduce infections using a combination of controlled burns and litter removal. Although the habitat utilized by *H. canadensis* in those sites is not one that has traditionally been maintained by fire, managers found that the removal of diseased plants and associated leaf litter in September—followed by a low intensity burn in March—effectively reduced disease and increased the number and vigor of Golden Seal plants (Rock 2000).

Synonyms

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

Botanical Synonyms

Hydrastis trifolia Raf.
Warneria canadensis Mill.
Warneria diphylla Raf.
Warneria tinctoria Raf.

Common Names

Golden Seal
Orange-root
Yellow Puccoon

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