

New England Plant Conservation Program

Onosmodium virginianum (L.) A. DC.
Virginia False-Gromwell

Conservation and Research Plan
for New England

Prepared by:
Ted Elliman, Ecological Consultant
95 West View Road
Voorheesville, New York

For:

New England Wild Flower Society
180 Hemenway Road
Framingham, Massachusetts 01701 USA
508/877-7630
e-mail: conserve@newfs.org • website: www.newfs.org

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SUMMARY

Onosmodium virginianum (L.) A. DC. (Virginia false-gromwell) is an herbaceous, perennial member of the borage family (Boraginaceae) that occurs in the Atlantic Seaboard and Gulf Coast states of North America from Massachusetts south to Florida and west to Louisiana. Due to its scarcity in New England, it has been classified as a Division 2 (Regionally Rare) taxon in New England by the New England Plant Conservation Program. Two populations have been recently documented in New England, both in Connecticut. These populations are located on dry, semi-open calcareous slopes with a partial overstory of red cedar (*Juniperus virginiana*). One of these sites is in Litchfield County, and the other is in Fairfield County. A number of other regionally rare plant taxa co-occur with *Onosmodium virginianum* at these sites. The historically dichotomous distribution pattern of *Onosmodium virginianum* in New England, occurring on calcareous inland bluffs on the one hand and on sandy coastal pine and shrublands on the other, is evident throughout its range.

Virginia false-gromwell has been collected at approximately 45 New England sites: in Connecticut (c. 25), Massachusetts (13), and Rhode Island (four or five). Almost all of the specimens were collected from the mid-19th century through the 1920's. Many collections took place in sandy habitats near the coast in Connecticut, Cape Cod, Martha's Vineyard, and Nantucket. It has never been documented in Maine, New Hampshire, or Vermont. Based on collection records, *Onosmodium virginianum* had all but disappeared from New England by the 1930's. The species also has almost vanished from the northern part of its original range along the Atlantic Seaboard. It is listed as historic or extirpated in Delaware, the District of Columbia, Massachusetts, Pennsylvania, and Rhode Island. It is reduced to one population each and ranked as a state-endangered (S1) plant in Maryland, New Jersey, and New York. In Virginia, it is ranked as an S2 species, and in North Carolina as an S3 species.

The tenuous viability of the taxon in New England presents challenges for its regional conservation. Protection and reintroduction measures must consider its specific habitat requirements, including its intolerance of shading, moisture, and competition with other plants. Little biological information has been published about the taxon, and any life-history data from parts of its range where it is more common (Georgia and Florida west to Louisiana) would be beneficial for its preservation in New England.

The conservation objectives for this species in New England are to secure and protect its two existing sites. Surveys of several of its historic locations in Connecticut should be undertaken to confirm its apparent disappearance from these sites. If these two sites cannot be maintained, or if research shows that additional populations would enhance the viability of the species in the region, it may be advisable to reintroduce the plant to two coastal areas where it formerly occurred. The reintroduction sites should be on conservation land where the populations can be closely monitored. One positive feature for reintroduction is the long-term viability of *Onosmodium virginianum* seed, which has germinated successfully in a variety of experimental conditions.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Because they contain sensitive information, full plans are made available to conservation organizations, government agencies and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

NEPCoP is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published “*Flora Conservanda: New England*,” which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of *Flora Conservanda* species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP’s Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection. If you require additional information on the distribution of this rare plant species in your town, please contact your state’s Natural Heritage Program.

This document should be cited as follows:

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I. BACKGROUND

INTRODUCTION

Onosmodium virginianum (L.) A. DC. (Virginia false-gromwell) is an herbaceous, perennial member of the borage family (Boraginaceae) distributed along the Atlantic seaboard from Massachusetts to Florida and west along the Gulf Coast to western Louisiana. Throughout its range, the plant's habitats include dry, calcareous woodland bluffs, often with an overstory of red cedar (*Juniperus virginiana*), and sandy pine woods and shrub communities along the coastal plain.

In New England, at the northeastern edge of its natural range, *O. virginianum* has disappeared from all of its former coastal sites. It now exists in only two locations in the marble valley region of western Connecticut in the Housatonic River drainage. In Massachusetts, which has 13 verified records of the species, it was last seen in 1920. In Rhode Island, with four or five records, it has not been documented since 1886. In Connecticut, with approximately 25 documented stations for the species, it had disappeared in all but two locations by 1933. The species has never been documented in Maine, New Hampshire, or Vermont (Brumback and Mehrhoff et al. 1996).

The two current Connecticut populations are located on dry, calcareous slopes. Both of these privately-owned sites have a thin overstory of red cedar, and both have other rare plant taxa characteristic of this regionally rare natural community. The Litchfield County site is in a scenic, accessible, and popular location near the Housatonic River. The *O. virginianum* population at this site is threatened by trampling and the proliferation of unofficial trails near the plants. This population had about 70 fruiting plants in 2003. The site's industrial owner is aware of the sensitivity of this occurrence, which is monitored annually by the Connecticut Natural Diversity Database program. The Fairfield County population had only two vegetative plants when it was last seen in 1998. The cedar bluff where the plants occur is owned by a construction company. This marginal population is not exposed to direct impacts, but the surrounding property is littered and disturbed. Future prospects for the site and this population are uncertain.

The species' pattern of habitat preference as well as its decline through the first three decades of the 20th century is replicated in other northeastern and Mid-Atlantic states. New York, for example, has one extant and 22 historic records with a habitat distribution similar to that of New England. New Jersey has one current population and 32 historic records. Maryland has a single remaining population in the Potomac River Gorge. *O. virginianum* is extirpated in Delaware and Pennsylvania, last collected in those states in 1890 (Delaware) and 1908 (Pennsylvania). In Virginia, the plant is ranked as an S2 species, occurring in pine woods in the coastal plain and on mafic outcrops in the state's Ridge and Valley area. From North Carolina south to Florida and west to Louisiana, *O. virginianum* is more common, typically occurring in sandy pinelands and in cedar glades with calcareous bedrock. It has never been reported in Canada, the

closest occurrence to Canada being an unconfirmed collection in the vicinity of Buffalo, New York (Zander and Pierce 1979).

The conservation of the species in New England will require immediate protection of the two current Connecticut sites. For the Litchfield County site, signage emphasizing habitat sensitivity and installation of a fence would reduce the threats of trampling the plants, which are clustered near an unofficial trail network above the Housatonic River. Periodic thinning of the red cedar overstory would help to maintain the filtered light conditions that *O. virginianum* requires. For the Fairfield County site, the immediate concern is the conservation of this privately-owned property. Acquisition by The Nature Conservancy or a regional land trust would facilitate monitoring and management for the protection of *Onosmodium virginianum* and the other rare plants on this marble bluff.

A problem for preservation and for possible reintroduction projects in the future is the lack of information on the species' biology and life history requirements (Al-Shehbaz 1991). Research into the plant's life history patterns would clarify the reasons for its regional disappearance, and provide guidelines for its future protection. Basic biological information, such as pollination, mechanisms of seed dispersal, annual variations in flowering/fruitlet, soil data including pH and mineral and organic components, shading, and herbivory, should be gathered about *O. virginianum* throughout its range.

Searches for the taxon should continue, particularly at historic Connecticut locations that may have been overlooked, such as sandy banks along the Naugatuck River, sand terraces near the Quinnipiac Marsh, and calcareous bluffs in Kent. In Massachusetts and Rhode Island, historic populations appear to be extirpated. Searches at a number of historical Massachusetts sites in the 1980's and 1990 failed to find any plants. Future searches at historical locations in these two states is not a conservation priority, but *de novo* investigations on circumneutral bluffs in the marble valley region of southern Berkshire County, Massachusetts is worth consideration.

DESCRIPTION

Onosmodium virginianum (L.) A. DC. is an herbaceous, perennial, erect, hairy plant 30-60 cm in height. The plant's oblong to elliptic leaves are mostly cauline, 4-6 cm in length by 1 to 2 centimeters in width, with three to five prominent veins. Bracteal leaves and a hispid, five-parted calyx with erect, linear divisions subtend the corolla, which is hairy on the outside and smooth on the inside. Each of the five acuminate corolla lobes is approximately 3 mm in length. The plant's tubular yellow flowers, which are borne on leafy, downward-curving (helicoid) cymes, are 7 to 10 millimeters in length. The filiform style is long-exserted from the flower, and the anthers, inserted in the corolla throat, wither before the corolla is fully developed. *Onosmodium virginianum* blooms in June and July. The fruits are smooth or slightly pitted nutlets approximately 2.5 mm in length and dull-white in color (MacKenzie 1905, Fernald 1950, Johnston 1954, Al-Shehbaz 1991, Gleason and Cronquist 1991).

Onosmodium molle Michaux. (softhair marbleseed), which has been reported in Connecticut and New Hampshire and several more of the same Mid-Atlantic and Gulf Coast states as *O. virginianum*, is distinguished from its congener by its greenish-white flowers. The corolla lobes of *O. molle* are more broadly triangular, being 1.5-2 times as long as wide (deltoid), as opposed to 2-3 times as long as wide (acuminate) in *Onosmodium virginianum*. While it also inhabits open glade communities, *O. molle* ranges farther west than *O. virginianum*, occurring throughout the Great Plains states as far west as Montana, Utah, and New Mexico. *Onosmodium molle* has five recognized subspecies: *O. m. ssp. bejarensis*, *O. m. ssp. molle*, *O. m. ssp. occidentale*, *O. m. ssp. subsetosum*, and *O. m. ssp. hispidissimum* (Al-Shehbaz 1991).

Recently, an *Onosmodium* species endemic to dolomite glades in Bibb County of central Alabama has been described as an independent taxon (Allison and Stevens 2001). This species, named *Onosmodium decipiens* J. Allison, has yellow corollas like *O. virginianum*, but the corolla lobes are deltoid. Other features that distinguish *O. decipiens* from *O. virginianum* include: longer stem length, longer stem hair length, and the stature of the anther apices, which reach the bases of corolla notches in *O. decipiens* while they are below the level of the notches in *O. virginianum*.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Onosmodium is an entirely North American genus with five species. Three of these species (*O. decipiens*, *O. molle* and *O. virginianum*) occur in the eastern United States (Al-Shehbaz 1991, Allison and Stevens 2001). Features that distinguish *Onosmodium* from other members of the Boraginaceae include its acute corolla lobes and its precociously sexual flowers, with the style and anthers maturing before the corolla has attained full size (Johnston 1954).

The taxon was first described by Andre Michaux in his *Flora Boreali-Americana* of 1803. Michaux named the plant *Onosmodium hispidum*; it was subsequently renamed *Onosmodium virginianum*. The name “*Onosmodium*” is based on likeness of the genus to an Old World borage genus, *Onosma*, which in Greek means “smells like an ass” (Al-Shehbaz 1991).

Obsolete names for *Onosmodium virginianum* include:

- *Lithospermum virginianum* L. 1753
- *Onosmodium hispidum* Michaux. 1803
- *Onosmodium virginianum* var. *hirsutum* Mack. 1905
- *Onosmodium scabrum* Roemer & Schultes 1819
- *Purshia hispida* (Michaux) Lehm.
- *Purshia scabra* (Roemer & Schultes) Nutt.

SPECIES BIOLOGY

In a monograph on the Boraginaceae, Al-Shehbaz wrote that “[h]ardly anything is recorded about the reproductive biology of *Onosmodium*” (Al-Shehbaz 1991: 135). I have not found any information to date about *Onosmodium virginianum* pollination biology or seed dispersal. One of the plant’s known reproductive characteristics is the precocial nature of the long-exserted style and the anthers. Both the style and anthers mature before the corolla has fully developed. This mechanism insures that self-pollination of the plant is almost impossible (Johnston 1954).

With respect to the Boraginaceae in general, the flowers are usually pollinated by bees, butterflies, and flies. For dispersal, many genera in the family have an aril-like structure attached to the base of the nutlets that contains sugars, fats, and free amino acids. These seeds are dispersed by ants. Nutlets may also be consumed and dispersed by browsing animals and birds (Judd et al. 1999).

Bill Brumback of the New England Wild Flower Society (personal communication) found that the seed of the species can persist for a period of years. Seed has germinated successfully in a variety of *ex situ* greenhouse and outdoor planting experiments at the Garden in the Woods. In 1991, Brumback received several years’-old seed collected by Les Mehrhoff from the CT .001 (Kent) site. Some of these seeds were refrigerated and some were not; in both cases, seeds germinated successfully. Further collections were done at CT .001 (Kent) in 1993 (600 seeds collected), and in 1996 (seeds collected from 26 plants). Trials with these seeds included cutting seed coats of some while leaving others intact; sowing some in the greenhouse and others outdoors; refrigerating some and not refrigerating others. In all cases, seed germinated successfully. According to Brumback, *O. virginianum* seed’s viability bodes well for long term seed banking of the species.

Tom Rawinski (cited in Edinger 2003: 48) observed that some of the *O. virginianum* plants at the only current New York station for the species grow along a deer trail and are subject to herbivory. Rawinski noted that this site was grazed by cattle until 1991 and speculated that *O. virginianum* may depend on grazing to maintain the open, partially disturbed conditions suitable for the plant’s germination.

HABITAT/ECOLOGY

Throughout its range, *Onosmodium virginianum* occurs in two general habitat types: sandy woodlands or shrub communities, often on the coastal plain; and semi-open woodlands with a circumneutral or calcareous substrate in inland locations. In both cases, the plant grows on dry soils. It grows in the open or under partial shade, associated with pine near the coast and with red cedar on inland bluffs.

Because the taxon disappeared in the northeast many decades ago, there is little ecological information about its habitat or associated species. Habitat information is

limited to brief references in floristic checklists and herbarium specimen labels. Historic New England records, for example, record the species on dry, sandy soil in a number of locations, but provide few details about associated vegetation. One of the most complete historical descriptions of *O. virginianum*, for Martha's Vineyard and Nantucket, states:

“Not at all a rare plant on Nantucket, as has been supposed, but confined to the northeastern corner of the island where it is locally common on dry ground through Squam, extending into Pocomo; farther west two plants have persisted for several years on a dry knoll near Aquidness Point. It is also locally common on Chappaquiddick Island, Martha's Vineyard...” (Bicknell 1915: 40).

The two current Connecticut populations and the only current New York population occur on dry marble bluffs with a dispersed canopy of eastern red cedar. Other rare plants that occur with *O. virginianum* at the Connecticut sites include: *Aristolochia serpentaria*, *Asplenium ruta-muraria*, *Bouteloua curtipendula*, *Draba reptans*, *Liatrix scariosa* var. *novae-angliae*, *Potentilla arguta*, *Solidago rigida*, and *Sporobolus clandestinus*. Les Mehrhoff of the University of Connecticut Herbarium (personal communication) believes that the species is relictual in New England, having arrived here during the post-glacial hypsithermal interval (8000 to 4000 years ago) when there was more open, dry habitat in the region, and diminishing in numbers ever since. Like other species with a similar provenance and habitat preference, its remaining New England outposts are dry, west-facing, open to partially shaded, calcareous slopes.

In the southeastern states, *O. virginianum* is associated with coastal long-leaf pine (*Pinus palustris*) woodlands and with limestone cedar glades. Bruce Sorrie of the North Carolina Natural Heritage Program, writing about the species in North Carolina, states:

“...In the mountains it inhabits glades or open woodlands on limestone, diabase glades in the piedmont, calcareous shell middens at the coast, and acidic longleaf pine-oak-wiregrass woodlands in the Sandhills... Within the longleaf ecosystem, (*O. virginianum*) inhabits sites with somewhat better soils (loamy sands) on upland flats and in slight depressions...these loamy sites depend on fire to maintain a relatively shrub-free condition...Managers set prescribed burns every three years if possible. I do not encounter (*O. virginianum*) in fire-suppressed communities, even if the original woody species are present, due to thick duff and excessive shade...” (personal communication).

Southeastern cedar glade communities are characterized as open, meadow-like grass-forb communities on dry limestone soils (Baskin and Baskin 1995). Glade openings are typically surrounded by woodlands of red cedar, persimmon (*Diospyros virginiana*), yellow oak (*Quercus muehlenbergii*), and winged elm (*Ulmus alata*). Glade soils are very dry during most of the growing season.

THREATS TO TAXON

Causes of the disappearance of *Onosmodium virginianum* over the last 150 years in New England and elsewhere in northeastern and Mid-Atlantic states are attributable to human impacts, natural processes, and to the plant's exacting habitat requirements. Development in the plant's former habitats in Connecticut (such as the sand plains in New Haven County), Massachusetts, and Rhode Island has most likely destroyed a number of historic populations. Fire suppression, abandonment of grazing lands, and the natural succession of open communities towards shaded woodlands with more organic soils may have rendered other sites too moist and shaded for its survival.

Les Mehrhoff (personal communication) has suggested that the natural tendency of the New England climate and landscape in geologic time has worked against the habitat conditions that the species requires. It is possible that centuries of Native American and natural burning of sandy coastal habitats, followed by the deforestation of the southern New England landscape from the colonial period through the 18th and 19th centuries, sustained the populations of a regionally scarce species. With post-agricultural reforestation, open habitats reverted to woodlands and forests, restricting the potential for the species' survival in southern New England. *Onosmodium virginianum* may require a certain kind and level of landscape disturbance (i.e. fire, grazing) to maintain a foothold in New England. Without these disturbances, it will yield to more shade-tolerant species.

Regarding the two current Connecticut populations, human and natural processes threaten their continued existence. The CT .001 (Kent) population, which is located near a popular overlook of the Housatonic River, is threatened by trampling. The tiny CT.012 (Brookfield) population is vulnerable to landscape abuses, such as trash dumping, and increased shading by the red cedar overstory.

DISTRIBUTION AND STATUS

General Status

Onosmodium virginianum (L.) A. DC. ranges from southern New England to western New York and south to central Florida and western Louisiana. It has only been documented in Atlantic Seaboard and Gulf Coast states. There are no known records of the taxon in Canada, and its range does not extend west of the eastern deciduous forest region. It has a global rank of G4, meaning it is secure on a global basis, and a National Heritage rank of N?, or unknown status (NatureServe 2004; see Appendix 2 for an explanation of ranks).

The plant increases in frequency and abundance from north to south. A warm climate and a larger area of suitable habitats explain the plant's greater presence in the southeast.

In states from Massachusetts to Maryland, the plant has been extirpated or reduced to one or two populations; from Virginia to Florida and Louisiana, it occurs more frequently (in Virginia it listed as an S2 species; in North Carolina it is S3; and farther south it is fairly widespread).

Table 1 lists all the states in which *O. virginianum* was formerly or is currently known. The state by state summaries after the table discuss details of its distribution and abundance in these states. The “SR” rank indicates “State Reported.” In all of the states where it has an SR rank (Table 1), *O. virginianum* is fairly common. It has been falsely reported (SRF) in Arkansas (Cindy Osborne, Arkansas Natural Heritage Commission, personal communication) and Kentucky. No verified records are known for these two states. The Connecticut, Massachusetts, and Rhode Island populations are discussed in detail in the next section. Figure 1 summarizes the taxon’s North American distribution. Additional information for several states is presented below.

Table 1. Occurrence and status of <i>Onosmodium virginianum</i> in the United States and Canada based on information from Natural Heritage Programs.			
OCCURS & LISTED (AS S1, S2, OR T & E)	OCCURS & NOT LISTED (AS S1, S2, OR T & E)	OCCURRENCE REPORTED OR UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Connecticut (S1)	North Carolina (S3)	Alabama (SR)	Delaware (SH)
Maryland (S1)		Arkansas (SRF)	District of Columbia (SX)
New Jersey (S1)		Florida (SR)	Massachusetts (SX)
New York (S1)		Georgia (SR)	Pennsylvania (SH)
Virginia (S2)		Kentucky (SRF)	Rhode Island (SH)
		Louisiana (SR)	
		Mississippi (SR)	
		South Carolina (SR)	

Alabama (SR): Frequent in the northern part of state, favoring limestone glades and river bluffs (Al Schotz, Alabama Natural Heritage Program, personal communication).

Connecticut (S1): Two extant and c. 20-25 historic occurrences (Ken Metzler and Nancy Murray, Connecticut Natural Diversity Database, personal communications).

Delaware (SH): There are two confirmed historic occurrences. One is from the coastal plain (1863) and one is from Piedmont (1890). County-based historical records indicate the species was “frequent” in the Piedmont in the 19th century, and “infrequent” by the 1940’s (Bill McAvoy, Delaware Natural Heritage Program, personal communication).

District of Columbia (SX): The DC Herbarium Database lists three collections of the species within the District of Columbia, all in the 1870’s.

Florida (SR): Occurs in 41 counties in the northern and central parts of state where it is widespread and abundant. Habitats include sandhills, flatwoods, and open hammocks on dry to submesic soils with deep acidic sandy soils overlying limestone (Linda Chafin, Florida Natural Areas Inventory, personal communication).

Georgia (SR): It is mentioned in old literature as occurring in dry pine woods in the central and southern parts of the state (Harper 1900a and 1900b). Al-Shehbaz (1991) notes that it is widespread in Georgia as well as in the Carolinas and north and central Florida.

Louisiana (SR): Present in 14 parishes, primarily in longleaf pine (*Pinus palustris*) and mixed pine forests (Chris Reid, Louisiana Natural Heritage Program, personal communication).

Maryland (S1): One extant population in the Potomac River Gorge, Montgomery County on loose rock near the river; formerly more widespread in the coastal plain and interior (Chris Frye, Maryland Department of Natural Resources, personal communication).

Massachusetts (SX): There are 13 historic occurrences (Paul Somers and Sergio Harding, Massachusetts Natural Heritage and Endangered Species Program, personal communications).

Mississippi (SR): Fairly widespread in dry, sandy pine woods and on calcareous bluffs (Heather Sullivan, Mississippi Natural Heritage Program, personal communication).

New Jersey (S1): One extant and 32 historic locations. Occurrences were on sandy coastal plain and dry limestone communities. (David Snyder, New Jersey Natural Heritage Program, personal communication; Snyder 1989).

New York (S1): One extant and 22 historic stations (Steve Young and Troy Weldy, New York Natural Heritage Program, personal communications).

Historic records in New York are primarily from dry, sandy woods in the southeastern part of state (e.g. Lamont and Stalter 1991), but several populations are known from central New York. There is an unconfirmed record from the Buffalo area (Zander and Pierce 1979). If this record is valid, it would be the northwesternmost known station for the species. Notes taken by the botanist G. W. Clinton in his journal in the summer of 1862 are the basis for this record. Clinton noted an *Onosmodium* species on four separate days, referring to it as either *Onosmodium virginicum* or *O. carolinianum*. He reported collecting a specimen on 22 July 1862 at Sulphur Spring “with my wife.” Calls and e-mails to the Clinton Herbarium and the Buffalo Museum of Science to confirm this record have not been returned. On the web, there is a posting of G.W. Clinton’s botanical journal for the Buffalo area in July, 1862 (<http://ridgwaydb.mobot.org/resbot/Hist/Diary/Diary1862July.htm>). Most New York populations were reported from the 1850’s to the 1920’s. A population was reported in Manhattan near the Harlem River in 1879, and another in Brooklyn in 1900. The state’s

single current occurrence is in a cedar glade with exposed marble in Dutchess County (Edinger 2003; Bob Zaremba, Botanical Consultant, personal communication).

North Carolina (S3): Formerly listed, now delisted as more populations were found in the 1990's. It occurs in the sandy pine woods on the coastal plain, on diabase in the piedmont, and in calcareous woodlands in the mountains (Bruce Sorrie, North Carolina Natural Heritage Program, personal communication).

Pennsylvania (SH): There are three historic occurrences, one in Delaware County and two in Lancaster County. The most recent record for the species in Pennsylvania is 1908 (Ann Rhodes, Morris Arboretum, personal communication).

Rhode Island (SH): There are four or five historic occurrences (Rick Enser, Rhode Island Natural Heritage Program, personal communication; Fred Jackson, Brown University Herbarium, personal communication; Ray Angelo, NEBC Herbarium, personal communication).

South Carolina (SR): No further information was available at the time of writing.

Virginia (S2): Populations occur in dry sandy soils in the coastal plain and in areas of mafic rock in the state's Ridge and Valley region. *Onosmodium virginianum* has been stable in Virginia since the state's Heritage Program began tracking it in the late 1980's (Johnny Townsend, Virginia Natural Heritage Program, personal communication).

Texas: Bill Carr (The Nature Conservancy-Texas) and Jason Singhurst (Texas Parks and Wildlife Department) confirmed that *O. virginianum* has not been documented in Texas.

Status of All New England Occurrences — Current and Historical

The Natural Heritage Programs of Connecticut, Massachusetts, and Rhode Island track a number of historical locations as well as the two current locations for *Onosmodium virginianum* in New England. Herbarium specimens provide additional site information about historical occurrences not tracked by the Heritage Programs. There are no documented records of the plant in Maine, New Hampshire, and Vermont. The New England Plant Conservation Program (NEPCoP) ranks *O. virginianum* as a Division 2 (Regionally Rare) taxon (Brumback and Mehrhoff et al. 1996).

Historical New England records are based on herbarium specimens. Details about habitat and location for these records are usually sketchy at best, and there is almost no information about population size.

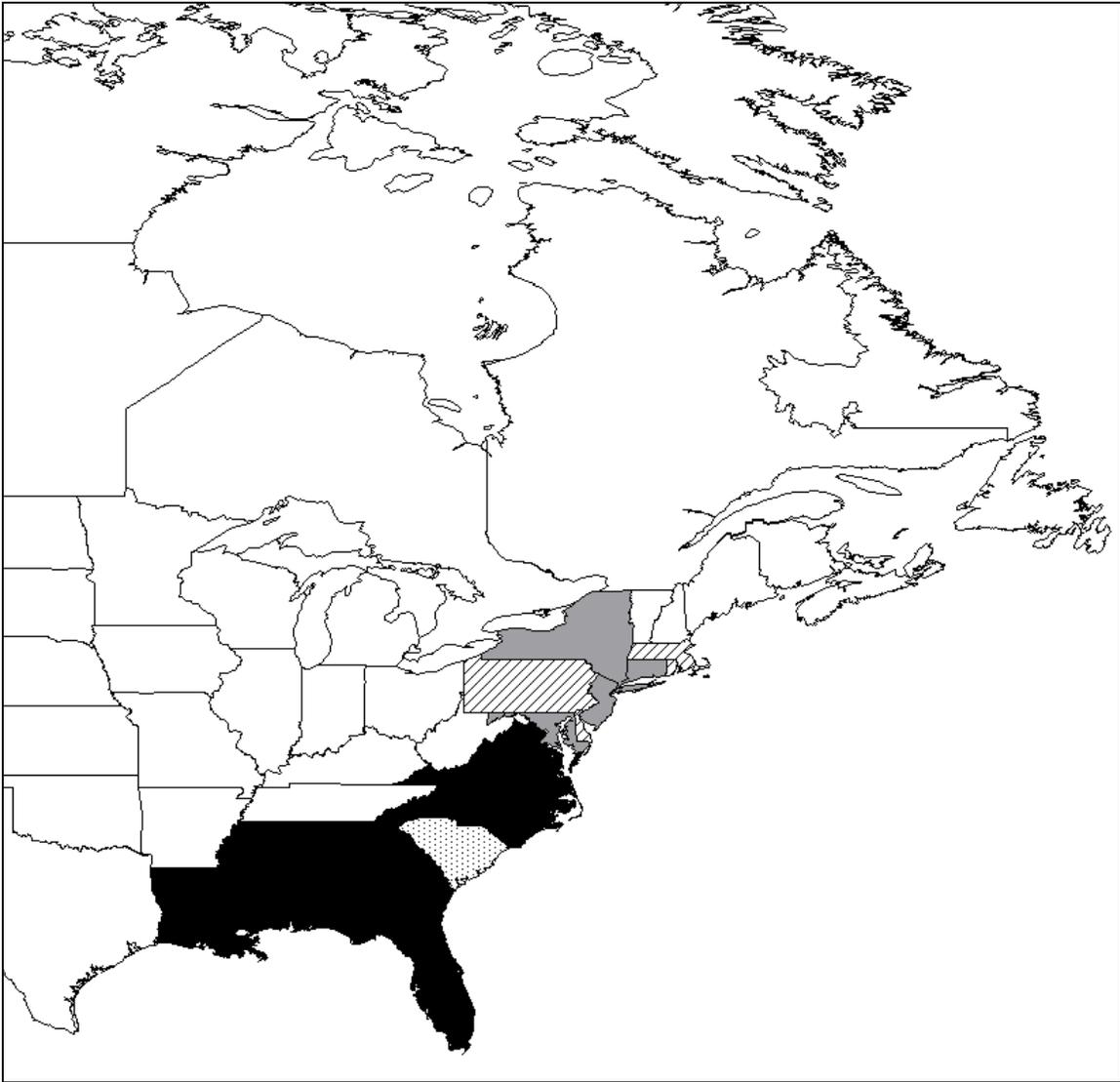


Figure 1. Occurrences of *Onosmodium virginianum* in North America. States shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. The states with diagonal hatching are designated “historic,” where the taxon no longer occurs. States with stippling are ranked “SR” (status “reported” but not necessarily verified or without further information). See Appendix 2 for explanation of state ranks.

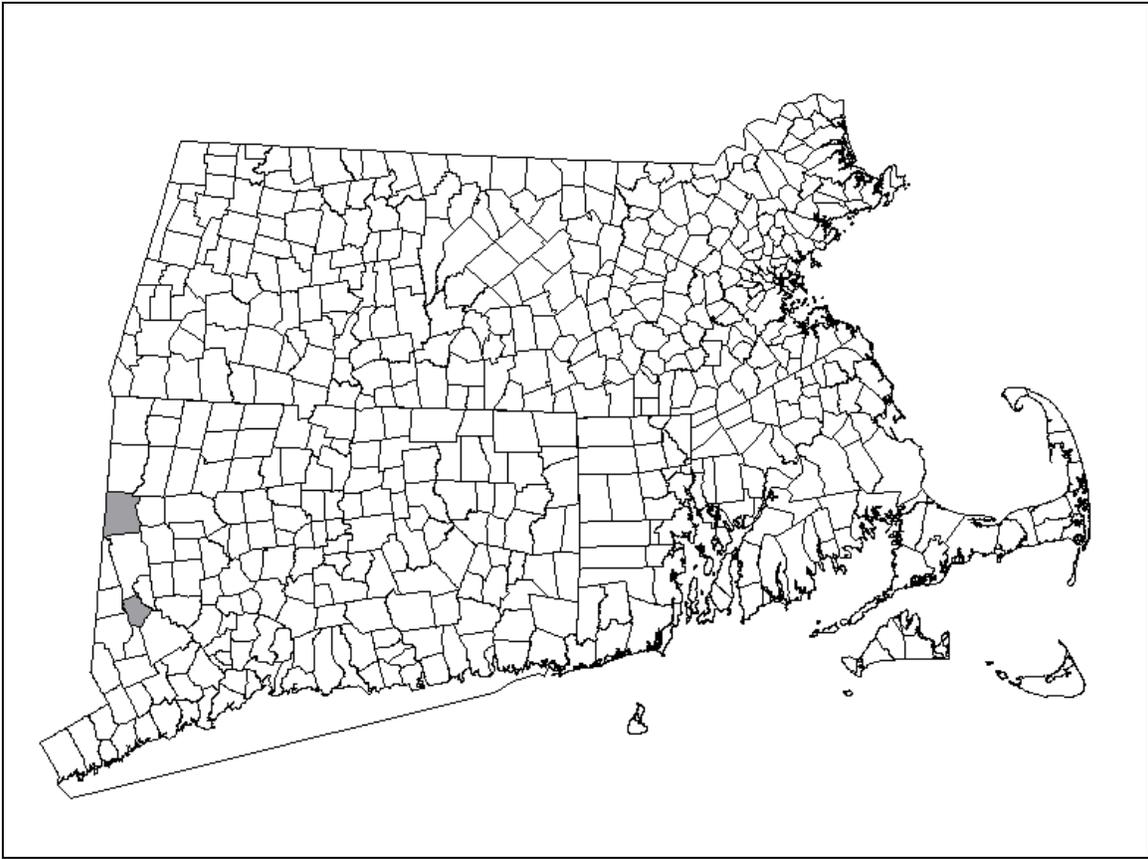


Figure 2. Extant occurrences of *Onosmodium virginianum* in New England. Town boundaries for southern New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

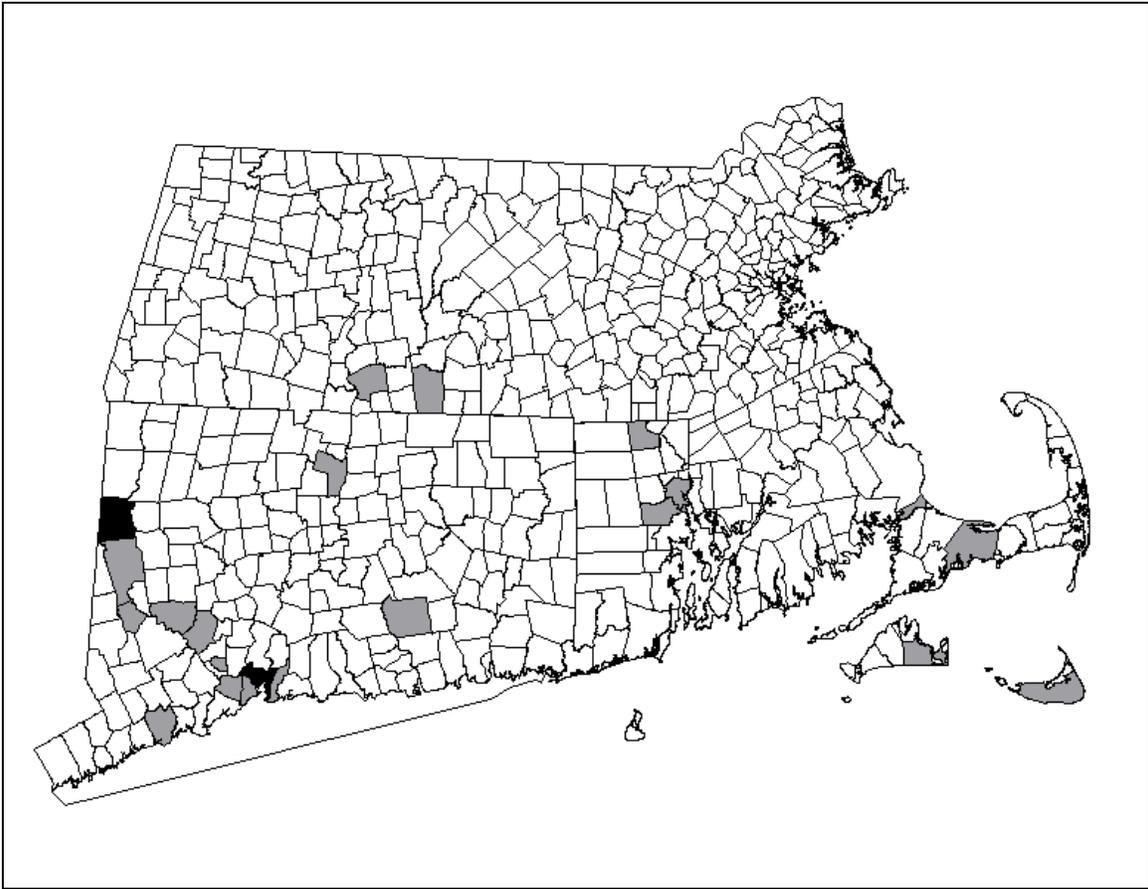


Figure 3. Historical occurrences of *Onosmodium virginianum* in New England. Towns shaded in gray have one to five historical records of the taxon. Towns shaded in black record more than five specimens.

**Table 2. New England Occurrence Records for *Onosmodium virginianum*.
Shaded occurrences are considered extant.**

State	EO #	County	Town
MA	.001	Dukes	Edgartown
MA	.002	Nantucket	Nantucket
MA	.003	Nantucket	Nantucket
MA	.004	Nantucket	Nantucket
MA	.005	Barnstable	Barnstable
MA	.006	Barnstable	Bourne
MA	.007	Barnstable	Bourne
MA	.008	Nantucket	Nantucket
MA	.009	Hampden	Springfield
MA	.010	Nantucket	Nantucket
MA	.011	Dukes	Unknown
MA	.012	Bristol	New Bedford
MA	.013	Hampden	Monson
RI	.001	Providence	Cranston
RI	.002	Providence	Providence
RI	.003	Providence	Cranston
RI	.004	Providence	Smithfield
RI	No #	Providence	Cranston
CT	.001	Litchfield	Kent
CT	.002	New Haven	Ansonia
CT	.003	New Haven	West Haven
CT	.004	New Haven	East Haven
CT	.005	Hartford	Windsor
CT	.006	Middlesex	East Haddam
CT	.007	Fairfield	Fairfield
CT	.008	Fairfield	Brookfield
CT	.009	New Haven	New Haven
CT	.010	New Haven	Orange
CT	.011	New Haven	Oxford
CT	.012	Fairfield	Brookfield
CT	A	Litchfield	Kent
CT	B	Litchfield	Kent
CT	C	Litchfield	Kent
CT	D	Fairfield	Fairfield
CT	E	Litchfield	Kent
CT	F	New Haven	New Haven
CT	G	Litchfield	New Milford
CT	H	Litchfield	Kent
CT	I	Fairfield	Southbury
CT	J	New Haven	Oxford

**Table 2. New England Occurrence Records for *Onosmodium virginianum*.
Shaded occurrences are considered extant.**

State	EO #	County	Town
CT	K	New Haven	New Haven
CT	L	New Haven	New Haven
CT	M	New Haven	New Haven
CT	N	New Haven	New Haven
CT	O	New Haven	Orange
CT	P	Litchfield	Kent
CT	Q	New Haven	Oxford
CT	R	New Haven	Ansonia
CT	S	New Haven	West Haven
CT	T	New Haven	New Haven
CT	U	Middlesex	East Haddam
CT	V	Litchfield	Kent
CT	W	New Haven	Ansonia
CT	X	Litchfield	Kent
CT	Y	Litchfield	Kent
CT	Z	Litchfield	Kent
CT	AA	Litchfield	Kent

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Before addressing conservation objectives, the question of why *Onosmodium virginianum* has nearly disappeared in New England and elsewhere in the northern part of its range should be reviewed. Based on limited information, I suggest the following reasons for its regional scarcity.

1. The plant became established in southern New England from its southeastern centers of distribution in open woodland communities on sand and dry limestone during the post-glacial hypsithermal (c. 8000-4000 years ago), which brought a warm, dry climate to the region.
2. Following the hypsithermal and the advent of cooler, moister, and more forested conditions inimical to its survival in the region, the plant kept a foothold in dry habitats subject to periodic burns from natural causes (lightning) and deliberately-set Native American fires.
3. Deforestation and widespread cultivation and pasturage of the landscape following European colonial settlement maintained suitable, open conditions for the plant at a limited number of sites (although conversion of fire-maintained grassland to cropland may well have destroyed populations). Disturbance by sheep and cattle grazing may have benefited the plants in some cases by keeping habitats open.
4. Post-19th century agricultural abandonment and fire suppression led to the reoccupation of *O. virginianum* population areas by woodlands, and the consequent disappearance of these shade-intolerant plants. Industrial, commercial, and residential development destroyed other population sites. These processes continue to have a direct impact on the taxon's welfare in New England.

It would be useful to know if grazing animals (both wild animals and livestock) played a role as seed dispersal agents that moved the plant around to suitable habitat patches during the pre-agricultural and agricultural periods.

With so many factors working against *Onosmodium virginianum* in the northeast, and so little known about its biology, it seems best to provide maximum protection for the two extant populations while learning as much as possible about its life history throughout its range. Conservation actions to achieve this objective include:

- 1) **Protect the CT .012 (Brookfield) site.** Fence off the northeastern subpopulation at CT .001 (Kent) and collect more complete information on the southeastern subpopulation. Search both sites thoroughly, especially CT .012, for more plants.

- 2) **Monitor CT .001 and CT .012 every year.** Collect data on plant numbers, flowering and fruiting patterns, pollination, recruitment success, and growth or contraction of populations. Take soil samples for an analysis of pH, nutrients, and organic matter. Note overstory shading patterns and the presence and abundance of associated plant species. To the fullest extent possible, determine the microhabitat conditions and disturbance factors that are most favorable for the plant.
- 3) **For more complete biological information, collect the same data on the nearby New York population in Dutchess County.** This population, which is discussed briefly in Edinger (2003), grows in habitat conditions similar to the Connecticut occurrences.
- 4) **Consider population augmentation as a management option if either or both populations decline.** This is especially the case for CT .012, which may have disappeared. Use propagules from the CT .001 population, which have been seed-banked at the New England Wild Flower Society, for augmentation. Site preparation (overstory thinning, removal of competing herbaceous species) should mimic the conditions where the plant is growing successfully (at CT .001, and the Dutchess County, New York site). Try to maintain minimum population numbers of 100 plants in at least two subpopulations at CT .001, and 10-20 plants at CT .012.

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IV. APPENDICES

1. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

1. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable to extirpation or extinction
- 4 = apparently secure
- 5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis -- that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction -- i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have been made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.