

New England Plant Conservation Program

Aristolochia serpentaria L.
Virginia Snakeroot

Conservation and Research Plan
for New England

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SUMMARY

Aristolochia serpentaria L., commonly known as Virginia Snakeroot, is a perennial herb in the Aristolochiaceae. Several varieties have been described in the past, but they are no longer recognized in most taxonomic manuals.

Aristolochia serpentaria occurs in 26 eastern states and is common in the southern and central part of its range, while becoming rare along its northern periphery. It is listed as a Division 2 species in *Flora Conservanda* (Brumback and Mehrhoff *et al.* 1996). Connecticut is the only New England state in which it is found, where it occurs at 12 known sites in ten towns. It grows in a variety of upland forest communities, but is more likely to be found in dry, somewhat rich, rocky, deciduous or mixed deciduous-coniferous woods in Connecticut. Farther south, it also has broad environmental requirements, occupying many upland soil and forest types.

Population trends for the species in Connecticut are unclear. One new population was discovered in 2001. Monitoring in 2001 of eight extant sites found that two populations had decreased, three had increased, and one had stayed the same. Several known populations are threatened by habitat modification, invasive species, or site fragility. Two extant populations have not been surveyed for several years. A number of historical sites may or may not harbor extant populations, because these populations have not been investigated since the time of their original documentation. Eleven additional towns in Connecticut may contain populations of *Aristolochia serpentaria*, based upon historic records.

Since populations of species at the edge of their geographic range tend to occur in marginal climatic conditions and are thus at greater risk of extirpation, adverse climatic conditions are likely to be a threat to *Aristolochia serpentaria* in Connecticut. Collection of plants for medicinal use may pose an additional threat, but marketing of herbal supplements containing *Aristolochia serpentaria* and other *Aristolochia* species has been banned in the U.S. and other countries due to the carcinogenic and nephrotoxic effect of aristolochic acid. Thus, it is unlikely that a great deal of collecting of *A. serpentaria* is currently taking place.

The conservation objectives for *Aristolochia serpentaria* in New England include: protection and maintenance of all extant populations in Connecticut; determination of land ownership for several populations; survey of historic sites to determine the extent of population loss; and survey for new populations. In most cases, active management is not necessary, although two populations that occur in road rights-of-way will require road maintenance to be integrated with managing the habitat for the species. Yearly monitoring of several extant populations should take place at least until the stability of the populations is ascertained, while less frequent monitoring is suggested for other occurrences.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information 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.

The New England Plant Conservation Program (NEPCoP) of the New England Wild Flower Society 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.

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I. BACKGROUND

INTRODUCTION

Populations of species at the edge of their geographic range are more likely to be at risk of extirpation than are centrally located populations (Lesica and Allendorf 1995). Since central populations occur in the most favorable conditions, populations at the edge of their range are likely to occur in conditions that are marginal for their survival.

Aristolochia serpentaria L. in New England is a good example of a species at the edge of its range. Occurring in 26 states in the eastern and southern United States, *A. serpentaria* has been documented no farther north on the east coast than in central Connecticut. Although it is rather common in the southern parts of its range, it is considered threatened in Connecticut, and is also rare in New York and New Jersey.

A conservation plan is needed to pinpoint actions essential to maintenance of viable populations of *Aristolochia serpentaria* in Connecticut. This plan summarizes existing knowledge of its species biology and habitat requirements, identifies knowledge gaps, and proposes conservation actions necessary to maintain Connecticut populations. These actions include collection of land ownership information and landowner contact, yearly monitoring of populations at several sites, active management at some sites, surveys to determine the existence of populations at historic locations that have the potential to still harbor the species, and seed banking of seeds from larger existing populations.

DESCRIPTION

The following description of *Aristolochia serpentaria* is compiled from several taxonomic sources (Correll and Johnston 1979, Gleason and Cronquist 1991, Zomlefer 1994, Flora of North America Editorial Committee 1997). Measurements given for plant parts differ slightly among the various treatments. *Aristolochia serpentaria* is beautifully illustrated in Zomlefer (1994).

Aristolochia serpentaria is a member of the Aristolochiaceae family. It is an erect to decumbent herbaceous perennial reaching up to 0.6 m in height, with a knotty rhizome. Leaves are cordate, alternate, and somewhat polymorphic, ranging in length from 5 to 18.5 cm and in width from 1 to 5 cm, with an acute to acuminate tip. In the southern part of its range, *A. serpentaria* exhibits both a narrow-leaved and a broad-leaved form, but only the broader-leaved form occurs in Connecticut (Fernald 1950).

Inflorescences form from the base of the stem, and are sometimes partially buried by fallen leaves. The perianth, 1-2 cm long, consists of a petaloid calyx (González and Stevenson 2000). It is brownish-purple and zygomorphic, with a gynostemium formed by the fusion of the androecium and style. There are six stamens. The perianth forms an elongated, S-shaped tube that is swollen at the base and constricted at the neck, just below an expanded limb. Similarly shaped perianths of other species of *Aristolochia* have been shown to be specially adapted for fly pollination (Zomlefer 1994, Proctor et al. 1996), and so it is very likely that *A. serpentaria* is fly pollinated, as well.

Pfeifer (1966) reports evidence for cleistogamy in some flowers. The structure of these flowers differs from the structure of insect-pollinated flowers:

Flowers of *A. serpentaria* suspected of being self-pollinating have very small and rudimentary perianths. The calyx tube is reduced to a conic cover over the gynostemium, barely adequate to accommodate the enclosed structures. A short, oblique gibbous tube is produced at the distal end of the calyx cone, its aperture being less than one millimeter in diameter and effectively plugged by the dense pilose hairs which clothe the whole flower. The gynostemium is somewhat aberrant when compared with that in a normal flower; there is, however, a full complement of six fertile anthers. The stigmatic lobes are unequally reduced; this is chiefly responsible for the abnormal appearance of the gynostemium. Material has not been available to allow an investigation of pollen tube growth or fertilization. The ovaries enlarge, but none of the specimens examined show conclusively whether the fruits present were produced from normal or cleistogamous flowers. The meager evidence suggests that either type may form fruit. (Pfeifer 1966: 120)

The geographic range of plants exhibiting apparent cleistogamy has not been investigated. One of the original reports, however, was from plants in East Haddam, Connecticut (Pfeifer 1966).

The fruit of *A. serpentaria* is an ellipsoid to subglobose, dehiscent capsule that is 1-2 cm in diameter and has six valves. Seeds are obovoid, 4-5 mm long, and minutely papillose. There is no information available concerning differences, if any, in capsule morphology or seed size or number between cleistogamous and chasmogamous flowers.

There are three other species of *Aristolochia* in New England, but none of them is easily confused with *A. serpentaria*. All are introduced. *Aristolochia clematitis* L. is an escaped herbaceous cultivar with a nearly straight calyx and flowers that occur in axillary clusters up to the top of the plant (Magee and Ahles 1999). The other two species, *A. tomentosa* Sims and *A. macrophylla* Lam., native to the southeastern and south-central United States, are twining, woody vines (Burk and Zebryk 2001).

Aristolochia serpentaria has been used both historically and in modern times as a medicinal herb. Its common name, snakeroot, originated because of its use by native Americans as a cure for snake bite (Magee and Ahles 1999). Other reported medicinal uses include treatment of rheumatism, pains, obstructions, worms, toothaches, sore throats, fever, sore noses, colds, and as a tonic (Moerman 1986).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Aristolochia serpentaria was first described by Linnaeus in 1753. Probably due to its highly variable leaf form, several additional species were later named. Many of these were eventually reduced to varieties of *A. serpentaria*. All varieties are now considered to be synonyms of *A. serpentaria* (e.g., Flora of North America Editorial Committee 1997), although in some older manuals that are still currently in use, *Aristolochia serpentaria* Linnaeus var. *hastata* (Nuttall) Duchartre is considered to be a distinct variety (Fernald 1950, Steyermark 1963, Correll and Johnston 1979).

Information on synonyms of *A. serpentaria* is available on several World Wide Web sites. The most complete listing is given by The Institute for Systematic Botany at the University of South Florida (Wunderlin and Hansen 2000). In addition, a list of synonyms is given in Pfeifer (1966).

Most of the synonyms were published in the nineteenth century, with two exceptions: *Aristolochia serpentaria* Linnaeus var. *nashii* (Kearney) H. E. Ahles was published in 1959, and *Endodeca serpentaria* (Linnaeus) Rafinesque var. *hastata* (Duchartre) C. F. Reed was published in 1982. Thus, although current treatments consider only *Aristolochia serpentaria* L., the debate over the taxonomic status of this species has continued until relatively recent times.

Synonyms include:

Aristolochia bartonii Klotzsch
Aristolochia convolvulacea Small
Aristolochia dodecandra Rafinesque
Aristolochia hastata Nuttall
Aristolochia nashii Kearney
Aristolochia officinalis Nees
Aristolochia polyrrhizos Sprengel
Aristolochia sagittata Muhlenberg
Aristolochia serpentaria Linnaeus var. *bartonii* (Klotzsch) Duchartre in DC.
Aristolochia serpentaria Linnaeus var. *hastata* (Nuttall) Duchartre
Aristolochia serpentaria Linnaeus var. *laxa* Duchartre
Aristolochia serpentaria Linnaeus var. *nashii* (Kearney) H.E. Ahles

In addition, *A. serpentaria* has been placed in three other genera: *Endodeca* as *Endodeca bartonii* Klotzsch, *Endodeca dodecandra* Rafinesque ex. Jackson, *Endodeca hastata* Rafinesque, *Endodeca polyrrhizos* (Sprengel) Klotzsch, and *Endodeca serpentaria* (L.) Rafinesque var. *hastata* (Duchartre) C. F. Reed ; *Psophiza* as *Psophiza undulata* Rafinesque; and *Pistlochchia* as *Pistlochchia serpentaria* (Linnaeus) Rafinesque.

SPECIES BIOLOGY

Aristolochia serpentaria is a perennial plant. Although no data exist on its longevity, a closely related species that occurs in the south-central United States, *A. reticulata* Nutt., lives at least 20 years (Rausher and Feeny 1980).

Aristolochia serpentaria flowers in Connecticut from June to August (Seymour 1969). The chasmogamous flower is protogynous, with the stigmas maturing before the stamens. Several features of its flower construction and development indicate that the species is probably fly-pollinated (Zomlefer 1994). For example, the mouth of the calyx has a dark red color that mimics carrion. The calyx contains a curved tube with patches of hairs that secrete nectar. The structure of the mouth of the calyx includes a flap above an enclosure, that allows easy access by flies. Once inside the calyx, the flies are trapped until the stamens mature. At this point, the flowers shrivel and the flies are able to escape, carrying pollen to another flower.

Several species in the genus *Aristolochia* exhibit floral thermogenesis through controlled biochemical reactions, but *Aristolochia serpentaria* has not been studied for this characteristic. Occurring in only nine extant angiosperm families, this process is typical of species in basal angiosperm families such as the Aristolochiaceae (Thien et al. 2000). It may be an adaptation that enhances floral development, or may favor pollination by beetles and flies (Thien et al. 2000).

The seeds of *A. serpentaria* exhibit no particular morphological specialization for dispersal. Seeds are apparently released from the dehiscent capsule, but their position close to the ground and the lack of surface features usually attributed to epizoochory (Sorenson 1986) preclude external dispersal by larger mammals. Seeds lack elaiosomes and are therefore unlikely to be dispersed by ants. They have no fleshy parts that would make them attractive to birds or other frugivores, and they have no plumes or wings for wind dispersal.

One possible dispersal mechanism is the harvesting and caching of seeds by small rodents such as mice and voles. Since the capsules are close to the ground, the seeds are easily within reach of these animals. Consumption of the embryo would destroy many of the seeds, but some might remain uneaten and viable.

No information is available concerning the dispersal mechanisms of seeds produced

from cleistogamous vs. chasmogamous flowers. In many species, cleistogamous flowers are borne in a different position on the plant than are the chasmogamous flowers, and this difference in position may influence dispersal (Schmitt et al. 1985, Baskin and Baskin 1998). The relative position of the two flower types is not known in *Aristolochia serpentaria*.

Aristolochia serpentaria, along with other species of *Aristolochia*, is the larval food source for the pipe vine swallowtail, *Battus philenor*. This butterfly is common in the southern United States and ranges into central New England, but is rare there (Klots 1951). The pipe vine swallowtail is considered to be a migratory transient in New York and Connecticut, and may have extended its range somewhat northward by using cultivated, non-native pipevines (*A. clematitis*, *A. tomentosa*, *A. macrophylla*) as larval food sources (Natureserve 2001). There are 11 USGS quadrangle records for the pipe vine swallowtail in Connecticut (Connecticut Department of Environmental Protection et al. 2002) and the species has been recorded in all of the New England states (Opler et al. 1995).

Aristolochia serpentaria contains aristolochic acids, chemicals poisonous to most insects but tolerated by *Battus philenor* (Sime et al. 2000). In a relationship similar to the one shown by the monarch butterfly and alkaloids in milkweed, aristolochic acids are sequestered by *Battus philenor* and make it poisonous to predators (Sime et al. 2000).

Adult females of *Battus philenor* are able to discriminate between broad-leaved and narrow-leaved individuals of *Aristolochia* (Rausher 1978, Rausher 1980, Rausher and Odendaal 1987). In longleaf pine forests in eastern Texas, where this phenomenon has been intensively studied, the broad-leaved *Aristolochia reticulata* grows sympatrically with *Aristolochia serpentaria*, which occurs there only as the narrow-leaved form of the plant. *Aristolochia reticulata* becomes tough and unpalatable to larvae as the growing season progresses, but, due to its relatively high leaf area, is the species of choice in the spring when the leaves are tender and succulent. *Battus philenor* adult females selectively oviposit eggs on *Aristolochia reticulata* early in the season and *Aristolochia serpentaria* later in the summer.

Both the narrow-leaved and the broad-leaved forms of *Aristolochia serpentaria* occur in the southern United States where *Battus philenor* is abundant. In the northern part of its range (including Connecticut), where *Battus philenor* is rare, only the broad-leaved form of *Aristolochia serpentaria* occurs (Fernald 1950). The diversification of leaf form in the south may be an adaptation by the plant for avoidance of herbivory in an area with abundant herbivores.

The differences in leaf form may also be an adaptation to environmental conditions. In the southeast, broader-leaved forms of *Aristolochia serpentaria* tend to grow in richer, relatively more mesic woodlands, while the narrow-leaved forms grow in drier, sandy sites with acidic soils (Allard, personal observation). The narrow-leaved form, with less leaf area for moisture loss, may be better adapted to drier conditions. Connecticut sites are more similar to the southern sites where the broader-leaved forms of *A. serpentaria* grow than they are to the

drier, sandy sites.

HABITAT/ECOLOGY

Connecticut is the only state in New England in which *Aristolochia serpentaria* occurs. Here, at the northern edge of its range, it occurs in slightly enriched, often rocky, usually dry woods, and often but not always on slopes. It may occur over a number of different rock types, including basalt, diorite, and marble, and often occurs intermixed with other plants (K. Metzler, Connecticut Natural Diversity Data Base, personal communication). Graves et al. (1910) list it as occurring in dry rocky woods in Connecticut. The lack of specificity in its habitat requirements makes it difficult to pinpoint by habitat for inventory.

If the habitat requirements for *A. serpentaria* are examined throughout its range, one is left with the impression that the species has little or no habitat specificity, other than that it avoids wetlands and non-forested areas. Some of the habitats mentioned in the literature include: rich moist woods and dry oak-pine woods in southwest Georgia (Thorne 1954); chestnut oak, red oak, and hickory forest over diabase in New Jersey (Cantlon 1953); hackberry and sweetgum bottomland forest in the Mississippi valley (Shelford 1954); longleaf pinelands and pine-oak-hickory woods in the Florida panhandle (Clewell 1985); and older shortleaf pine stands (Billings 1938) and dry to mesic oak and oak-hickory forests (Oosting 1942) in the North Carolina Piedmont.

In Michigan and New York, where, like Connecticut, *Aristolochia serpentaria* is both rare and at the northern edge of its range, more specific habitat information is available. Michigan populations tend to occur in dry to mesic forests on slopes leading down to wetlands or bodies of water, or on mesic, forested flood plains (M. Penskar, Michigan Natural Features Inventory, personal communication). In New York, *A. serpentaria* is usually in chestnut oak (*Quercus prinus*) forests on rocky slopes, and is associated with *Carex pennsylvanica*. Within these forests, populations seem to be located in drainage catch points along the slope where leaves accumulate (T. Weldy, New York Natural Heritage Program, personal communication).

Both in Connecticut and in other parts of its range, *Aristolochia serpentaria* seldom occurs in large patches but is scattered throughout the forest. Rather than being an indication of rarity, this may be another way in which *Aristolochia serpentaria* avoids herbivory. A single plant of *Aristolochia serpentaria* does not provide enough food for a larva of *Battus philenor* to mature to the pupal stage. After consuming all edible material on a plant, the larva must move on the ground until it finds another plant to eat. A larva often feeds on at least 25 plants in order to complete its development (Rausher 1980). Widely-spaced plants of *Aristolochia* may act to control populations of *Battus philenor* by reducing the survival rate of its larvae.

THREATS TO TAXON

Known threats to populations of *Aristolochia serpentaria* in Connecticut include habitat loss, habitat modification, and competition from invasive species. Five extant populations are currently threatened by habitat loss or modification of various types or by invasive species (CT .004 [Guilford], CT .005 [New Haven], CT .006 [Hamden], CT .009 [Lyme], and CT .012 [Kent]). The Guilford population was nearly extirpated in 1998, but appears to be recovering. Not enough field work has been done at the other sites to document declines.

In addition to known threats, a number of other potential threats exist. *Aristolochia serpentaria* populations in Connecticut and elsewhere may have been reduced or eliminated through over-collection by herbalists. It was reported by Johnson as early as 1892 that *A. serpentaria*, while formerly common in southwestern Connecticut, was prized as a medicine and had been nearly extirpated there due to over-collection. Collection in earlier times may be responsible for present-day limits in the number of populations of *A. serpentaria*.

Modern research has shown that aristolochic acid, present in *Aristolochia serpentaria* and other species of *Aristolochia*, is a potent carcinogen and can cause kidney damage and failure (U. S. Food and Drug Administration 2001). The use of *Aristolochia* in herbal supplements is banned in the U. S. as well as in several other countries, and a Consumer Advisory concerning dietary supplements containing aristolochic acid was recently issued (U. S. Food and Drug Administration 2001). As information about the toxicity of *A. serpentaria* becomes more widely known, its attractiveness as a medicinal herb may decline and thus the threat from collection may lessen.

Most species in the genus *Aristolochia* have a tropical or subtropical distribution, and few can withstand freezing temperatures (Pfeifer 1966). *Aristolochia serpentaria*, as the most northerly distributed of all *Aristolochia* species, is unusual in its ability to live in a cooler climate. In Connecticut, *A. serpentaria* is at the northern edge of its geographic range. Since species at the northern edge of their range tend to occur in marginal climatic conditions and are thus at greater risk of extirpation (Lesica and Allendorf 1995), a cooling trend in climate or an increase in climate variability would probably threaten Connecticut populations of *A. serpentaria*.

At this point in time, in contrast, we are experiencing a global warming trend. The responses of individual species to global warming are difficult to predict. One possible consequence of climate warming might be the amelioration of climatic conditions in Connecticut, thus making it easier for *A. serpentaria* to survive there, or even making it possible for this species to expand its range northward. Climate warming can have secondary results such as changes in interspecific competition, changes in the distribution and abundance of herbivores, and changes in ecosystem disturbance regimes, and these influences may be either negative or positive for any particular species (Fox et al. 1999). Thus, although global warming has the potential to either increase the abundance or pose a threat to *A. serpentaria* in Connecticut, it is

not possible to pinpoint the exact mechanisms by which either scenario would take place.

A. serpentaria produces cleistogamous as well as chasmogamous flowers. While self-fertilization ensures the production of seeds in the absence of pollinators or potential mates, the consequence of this strategy is a reduction in the exchange of genetic material and thus a potential loss of genetic variability and therefore fitness (Berg and Redbo-Torstensson 1998, Herlihy and Eckert 2002). Differences in ratios of cleistogamous to chasmogamous flowers across the geographic range of *Aristolochia serpentaria* have not been studied. It is possible that higher rates of production of cleistogamous flowers may occur in Connecticut and in other edge-of-range populations, since this has been shown for peripheral populations of other species (Wyatt 1986, Herrera et al. 2001). This would indicate that Connecticut populations would exhibit a lower degree of genetic variability than centrally located populations.

DISTRIBUTION AND STATUS

General Status

Aristolochia serpentaria is distributed in dry, rocky, often calcareous woodlands in 26 states, occurring in the East, Midwest, and South. It has been extirpated from one state and the District of Columbia. It is listed as a Division 2 species in *Flora Conservanda* (Brumback and Mehrhoff et al. 1996), which is defined as a regionally rare taxon with fewer than 20 occurrences within New England. Its global rank is G4 and its U. S. national rank is N4. It is relatively common throughout the central and southern U. S., but becomes rare at the northern edge of its range. The North American distribution of *A. serpentaria*, both historic and extant, is presented in Figure 1. The current distribution in New England is shown in Figure 2, while Figure 3 depicts the historic New England distribution.

The distribution and current state and sub-national ranks of *A. serpentaria* are presented in Table 1.

Table 1. Occurrence and status of <i>Aristolochia serpentaria</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 (S2): 12 extant and up to 11 historic occurrences, Threatened	Delaware (S4)	Alabama (SR)	District of Columbia (SX)
Iowa (S1): southeast only (NatureServe Explorer 2001), Threatened	Illinois (S3S4)	Arkansas (SR)	Kansas (SX)

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OCCURS & LISTED (AS S1, S2, OR T & E)	OCCURS & NOT LISTED (AS S1, S2, OR T & E)	OCCURRENCE REPORTED OR UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Michigan (S2): southern lower Michigan (NatureServe Explorer 2001), Threatened	Kentucky (S?)	Florida (SR): all but southern FL (Wunderlin 1982)	
New York (S1): 3 extant, 5 historic, and 8 extirpated occurrences, all in Hudson Highlands (S. Young, New York Natural Heritage Program, personal communication), Endangered	Maryland (S4)	Georgia (SR)	
	New Jersey (S3)	Indiana (SR): present throughout the state (NatureServe Explorer 2001)	
	North Carolina (S5)	Louisiana (SR)	
	West Virginia (S?): present throughout the state (Natureserve Explorer 2001)	Mississippi (SR)	
		Missouri (SR)	
		Ohio (SR)	
		Oklahoma (SR)	
		Pennsylvania (SR)	
		South Carolina (SR): present throughout the state (Mousseau 2001)	
		Tennessee (SR): present throughout the state (Chester et al. 1997)	
		Texas (SR): present only in the Pineywoods and Cross Timbers regions (Hatch et al. 2001)	
		Virginia (SR)	

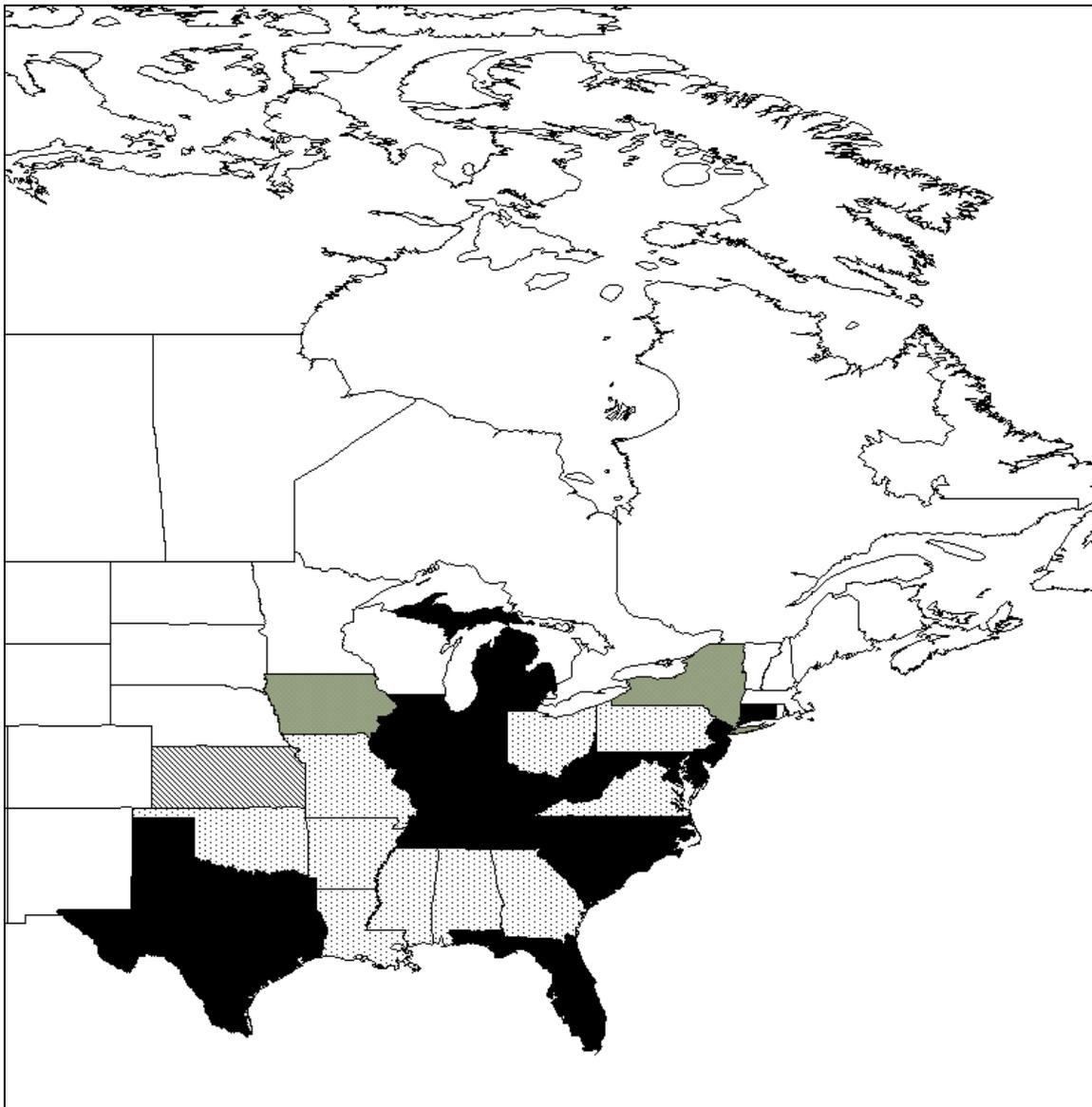


Figure 1. Occurrences of *Aristolochia serpentaria* in North America. States shaded in gray have one to five current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. States with diagonal hatching are designated "historic" or "presumed extirpated," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix 1 for explanation of state ranks).

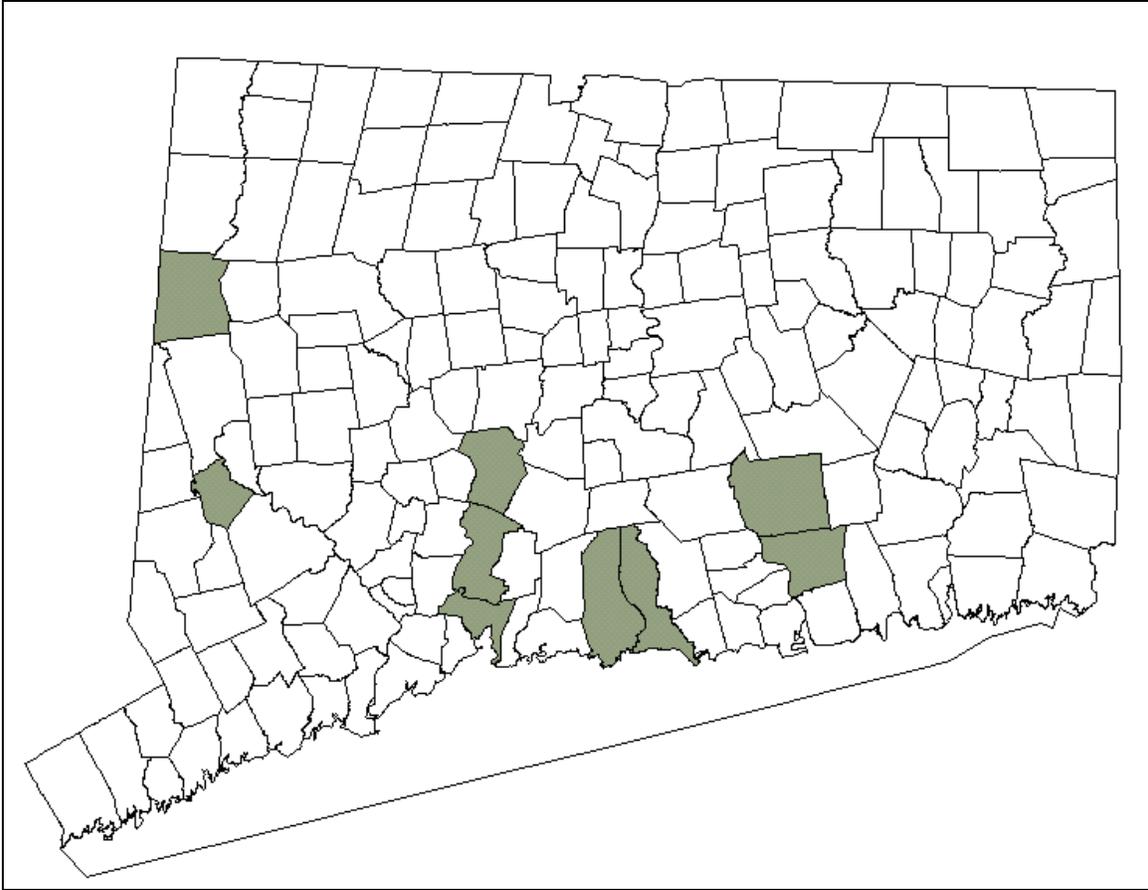


Figure 2. Extant occurrences of *Aristolochia serpentaria* in New England. Town boundaries for Connecticut are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

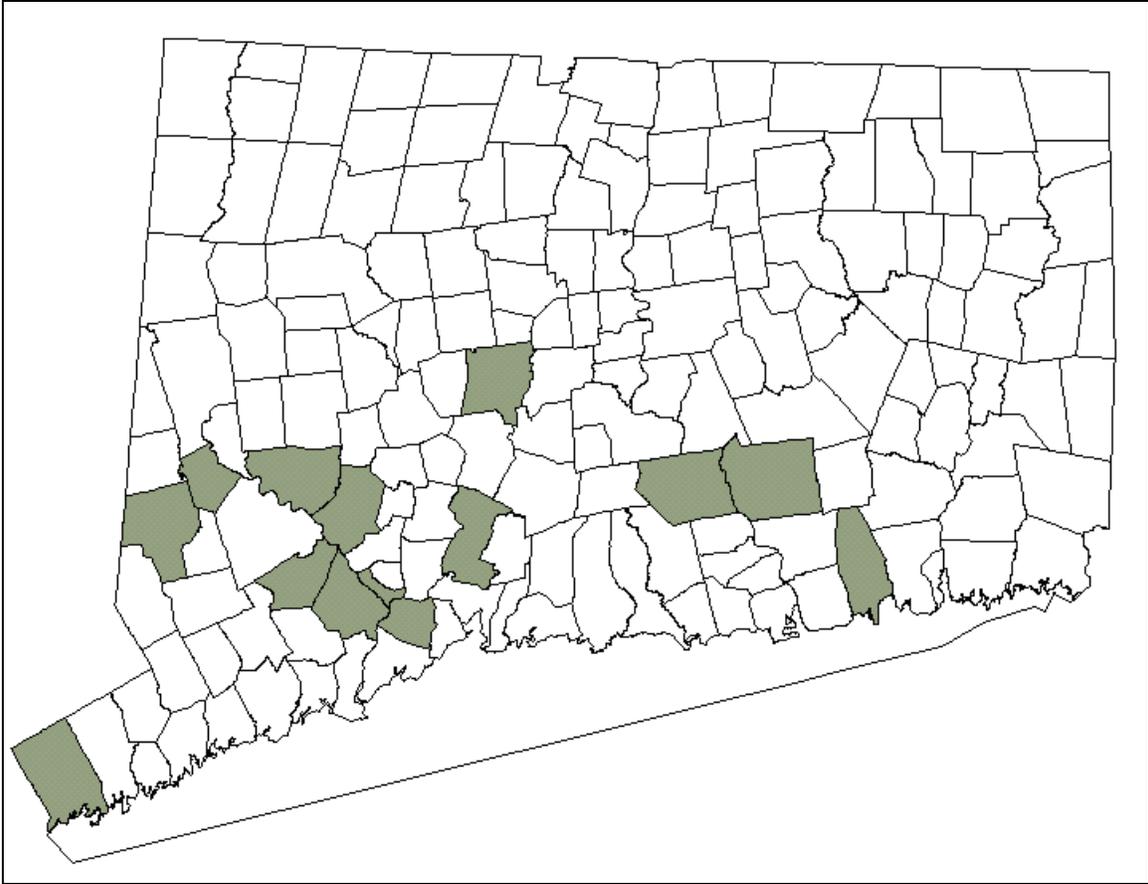


Figure 3. Historic occurrences of *Aristolochia serpentaria* in New England. Towns shaded in gray have one to five historic records of the taxon.

Status of All New England Occurrences -- Current and Historical

Within New England, *Aristolochia serpentaria* is present only in Connecticut, where it has been identified at 27 stations. Of the 27 occurrences, 12 are extant, and possibly 15 are historic records from herbarium specimens. The lack of detailed location information on herbarium labels makes it difficult to determine the exact number of original populations. Some of the herbarium specimens may have been collected at the locations of extant occurrences or may be collections made at one location by different botanists at different times, but there appear to be at least 11 historic populations in addition to the extant populations. Two historic sites (CT .001[Greenwich], CT .003 [East Haddam]) are in private or public land reserves and have a high potential for still supporting the species, since they have not been developed.

Element Occurrence (EO) ranks are given in Table 2. These ranks are assigned by the state Natural Heritage programs for each population, and are developed from an assessment of population size and productivity, condition, viability, and site defensibility. Ranks range from excellent (A) to poor (D). A rank of E is given when an occurrence is known to be extant but there is not enough information to assign a more specific rank. A rank of H is given for sites in which individuals of the population have not been observed for more than 20 years. If the EO Rank column for an occurrence is blank or contains a question mark, no rank has been assigned.

Because the data are sparse and so many of the occurrences represented by herbarium specimens have not been checked in recent times, it is difficult to tell from these statistics whether or not populations of *Aristolochia serpentaria* have declined in Connecticut. None of the historic records has been checked for the possibility of extant populations. Unfortunately, label data on most specimens does not allow for easily tracking the original collection sites.

For most of those sites that have been monitored, frequency of monitoring has not been great enough to determine with any degree of confidence whether numbers of plants in populations show a trend over time. Several populations have not been visited on a yearly basis. Monitoring efforts have not included marking of plants, and because the species is difficult to pinpoint in the field, individuals may be missed unless they are marked. Another difficulty with monitoring is that since flowers of *A. serpentaria* tend to become buried by fallen leaves, close inspection of each plant is necessary to identify flowering versus vegetative individuals.

**Table 2. New England Occurrence Records for *Amerorchis rotundifolia*.
Shaded occurrences are considered extant.**

State	EO #	County	Town
CT	.001	Fairfield	Greenwich
CT	.002	New Haven	Orange
CT	.003	Middlesex	East Haddam
CT	.004	New Haven	Guilford
CT	.005	New Haven	New Haven
CT	.006	New Haven	Hamden
CT	.007	New Haven	Hamden
CT	.008	New Haven	Cheshire
CT	.009	New London	Lyme
CT	.010	New London	Lyme
CT	.011	New London	Lyme
CT	.012	Litchfield	Kent
CT	.013	Fairfield	Brookfield
CT	No EO #	Hartford	Southington
CT	No EO #	Fairfield	Brookfield
CT	No EO #	Fairfield	Danbury
CT	No EO #	Fairfield	Monroe
CT	No EO #	Fairfield	Shelton
CT	No EO #	New Haven	Derby
CT	No EO #	New Haven	Madison
CT	No EO #	New Haven	Orange
CT	No EO #	New Haven	Oxford
CT	No EO #	New Haven	Southbury
CT	No EO #	Middlesex	Haddam
CT	No EO #	Middlesex	East Haddam
CT	No EO #	New London	East Lyme
CT	No EO #	New London	East Lyme

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

In New England, *Aristolochia serpentaria* has been found only in Connecticut, where it is listed as Threatened. A Threatened species is defined by law in Connecticut as "any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within the state and to have no more than nine occurrences in the state" (Connecticut Department of Environmental Protection 2002). As stated in Public Act 89-224, Section 9, endangered and threatened species are protected on public property and their collection for commercial purposes is prohibited by law on any lands, but they are not protected from incidental takings on private lands (Connecticut General Assembly 2002).

Ongoing conservation measures in Connecticut by the Connecticut Natural Diversity Data Base (NDDDB) include monitoring of several of the populations known to be extant. The Connecticut NDDDB has monitored four of the 11 extant occurrences (CT .004 [Guilford], .CT 009 [Lyme], CT .012 [Kent], and CT .013 [Brookfield]) during the last ten years, although monitoring has not taken place on an annual basis. No seed banking has been done (C. Mattrick, New England Wild Flower Society, personal communication).

In addition to monitoring completed by the NDDDB, the New England Wild Flower Society has monitored a number of populations as part of its Plant Conservation Volunteer program (Farnsworth, New England Wild Flower Society, personal communication). These data, though not yet included in Heritage files, have been incorporated into this document.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Aristolochia serpentaria is a rare species in New England. Its range strongly suggests that its northern extent is limited by climatic factors, since it is restricted to Connecticut and is found primarily in the southern third of the state. Within its natural range in Connecticut, its rarity is probably due to climatic factors that limit its abundance. Habitat loss, habitat degradation, and past collection for medicinal use also play a role. In addition, *A. serpentaria* naturally occurs in small populations.

The primary conservation objective for this species in New England is maintenance of populations and their habitats at the 12 known extant locations within Connecticut. Populations growing in roadside areas and with invasive species are at greatest risk and therefore require the most immediate action. For all extant populations, to date, surveys have not been frequent enough, nor have they been performed in a consistent enough manner, for true population size and degree of fluctuation from year to year to be adequately understood. Once thorough inventories have been completed, the current number of individuals existing in these populations should be maintained, and in some cases increased, although small populations are acceptable and probably natural if the habitat is not disturbed.

A secondary conservation objective is to determine if historic populations still exist, and also to search for other, as yet undocumented, occurrences of the taxon. While information on some historic records is not specific enough to justify a search, two historic locations (CT .001 [Greenwich], CT .003 [East Haddam]) are in private or public land reserves and could be investigated with relative ease, since there is no need to research land ownership. These historic sites have a high potential for continuing to harbor the species, in view of the fact that they have not been developed.

In addition to the historic sites, since *A. serpentaria* is easy to overlook, there is a reasonable chance that the species occurs in additional sites within its range in Connecticut. Botanists conducting research in southern Connecticut should be familiar with its appearance and habitat so that they will be alert to the possibility of finding new populations.

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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 EO's have received such ranks in all states, and ranks are not necessarily consistent among states as yet.