Conservation Assessment
for
Appalachian Bugbane (Cimicifuga rubifolia Kearney)

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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

Cimicifuga rubifolia is a large herbaceous perennial found primarily in the southern Appalachian Mountains with disjunct populations in Illinois, Indiana, Kentucky, and Pennsylvania. The species occupies north-facing slopes in undisturbed mesic forests often along streams in clay soils over calcareous rock. *Cimicifuga rubifolia* is rare throughout its range, globally classified as G3, and is state listed as imperiled or critically imperiled in Illinois, Indiana, Kentucky, and Virginia in addition to being a Regional Forester Sensitive Species on the Shawnee National Forest. Populations range in size from three individuals to over 5000 ramets. Although, *C. rubifolia* is rhizomatous, it almost exclusively undergoes sexual reproduction. Bumblebees pollinate the nectarless plant, which relies on other nectar-producing plants, primarily *Impatiens pallida* and *Polymnia canadensis*, to attract the pollinators. The seeds undergo epicotyl dormancy and typically require two periods of stratification to produce seedlings. There appears to be little gene flow between *C. rubifolia* populations and the majority of genetic variation apparently comes from genetic drift and the presence of rare alleles in a few populations. Threats to the species include logging, predation by insects and cattle, competition from invasive species, damage from ATVs and horses, dam construction, flooding, and urbanization. Although other members of the genus are used medicinally and as ornamentals, there is no evidence of *C. rubifolia* being collected and/or propagated for such purposes.

The U. S. Forest Service identifies species that are sensitive within each region, i.e., Regional Forester Sensitive Species (RFSS). For each RFSS a conservation assessment is developed to help maintain viable populations of these species. The purpose of this assessment of *Cimicifuga rubifolia* is to document the current scientific knowledge of the species. Specific objectives include the following:

1) describe the plant and distinguish it from other similar species,
2) determine the status of the species including geographical distribution and population trends,
3) determine ecological requirements of the species and its reproductive biology, and
4) identify threats to the species.

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NOMENCLATURE AND TAXONOMY

Scientific Name: *Cimicifuga rubifolia* Kearney
Common Names: Appalachian Bugbane, Black Cohosh, and Rattletop.

Synonyms: *Cimicifuga racemosa* (L.) Nutt. var. *cordifolia* (Pursh) Gray *p.p*. and *Cimicifuga cordifolia* Pursh *p. p*. Both of these have been misapplied (Ramsey 1965, Gleason and Cronquist 1991, Flora of North America Editorial Committee 1997).
Actaea rubifolia (Kartesz and Meacham 1999). *Cimicifuga rubifolia* is listed as a synonym for *Actaea rubifolia* but *A. rubifolia* is not listed as a synonym for *C. rubifolia*. NatureServe (2001) also lists *A. rubifolia* as synonym for *C. rubifolia*.
Class: Dicotyledoneae
Order: Ranunculales
Family: Ranunculaceae

Cimicifuga is considered to be a rather isolated and archaic group in Ranunculaceae (Pellmyr 1986). The genus name is derived from "cimex," a bug, and "fugere," to drive away (Fernald 1950), hence the common name bugbane. The specific epithet was chosen because of the resemblance of the terminal leaf to *Rubus odoratus* (Ramsey 1965). There are 12 species of *Cimicifuga* found in North American and Eurasia (Flora of North America Editorial Committee 1997), 6 of which are found in the U.S. The U. S. species consist of three eastern species, which includes *C. rubifolia*, and three western species.

Cimicifuga rubifolia was described by Kearney (1897) but the species was not generally recognized as a distinct species until Ramsey (1965) attempted to clarify some of the confusion with this taxon. For decades the species was not recognized in many manuals and floras. Apparently much of the confusion was caused by authors examining herbarium specimens, one of which was a mixed collection of *C. racemosa* and *C. americana*, instead of fresh material and the examination of some rarely encountered large *C. racemosa* specimens with some cordate leaflets (Ramsey 1965). For a detailed explanation of the taxonomic confusion see Ramsey (1965) and Kearney (1897).

DESCRIPTION OF SPECIES

Plant	perennial herb.
Rhizome	thick, knotty, irregular, horizontal, up to 10 cm long with numerous strong, fibrous roots.
Stem	single, erect or ascending, 30-150 cm tall, glabrous, often maroon-tipped, rather stout at base but diminishing quickly toward the summit, acutely 4-angled below, almost terete toward summit, more or less sulcate.
Leaf	petiole angled, 20-50 cm long, sheathing the stem-base, sulcate, densely pubescent in grooves, otherwise glabrous or sparsely pubescent.
	blade ternate to biternately compound (3-branched with each branch 3-branched); leaflets 3-9 (17), the terminal division usually consisting of a single leaflet much

larger than the others, the terminal leaflet of central segments broadly obovate to orbicular, deeply 3-5 lobed, 9-30 (usually 14-17) cm long, 9-25 (usually 15-16) cm wide, with 5-9 prominent veins arising basally; base deeply cordate, margins coarsely and irregularly dentate, apex sharply acuminate, upper surface deep green, smooth, lower surface paler, smooth or with long, appressed hairs on raised veins; the lateral divisions trifoliate, 8-24 cm long, 6-22 cm wide.

Inflorescence elongated, erect panicles of 2-6 racemelike branches, terminal raceme 15-30 (usually 20) cm long, puberulent or short-pubescent; bracts 3, subtending pedicel, central bract 2 mm long, lanceolate, the 2 remaining lateral bracts 1 mm long, ovate-deltate; pedicel in flower 2 mm long, in fruit 4-5 mm long, short-pubescent, bracteoles absent.

Flower sepals 5, falling off when or shortly after the bud opens, 4.5-5 mm long, 3-4 mm wide, ovate-suborbicular, white to yellowish-white, smooth, ciliate or entire; petals absent; stamens 35-65 on a slightly elevated receptacle; filaments white, 3-5 mm long, filiform but slightly broadening upward; anthers 0.5 mm long, yellowish-white; pollen 21 microns or less, distinctly tricolpate; pistil 1 (2), sessile, 2 mm long, sparsely glandular; style short, straight or slightly recurved; stigma minute, 0.2-0.3 mm wide; ovary 0.7 mm in diameter, glabrous, strongly compressed laterally.

Fruit 1 (2) follicle(s), sessile, oblong, strongly compressed laterally, 8-21 mm long, beaked by the style, pale green, thin walled.

Seeds usually 6, 4 in 2 rows, the other 2 solitary, reddish brown, lenticular, 3mm long, 1.5 mm wide, covered with reddish brown membranous scales especially along the edges where they form a well-developed deeply lacerate wing. (Although Cook (1993) indicated that Ramsey (1987) reported *C. rubifolia* has 8-9 seeds/follicle, this author finds no evidence of Ramsey reporting more than 6 seeds/follicle.)

Chromosomes 2n = 16.

This species description was obtained from Kearney (1897), Ramsey (1965), Kral (1983), Flora of North America Editorial Committee (1997), and Miller (2000). For a more detailed description of the species see Kearney (1897) and Ramsey (1965).

It has been reported that *C. rubifolia* lacks staminodia (Ramsey 1965, Ramsey 1987); however, Pellmyr (1986) found staminodia in the outer whorl of stamens. He described them as 3 mm long, forked, somewhat pointed at the apex, and slightly thickened in the central portion. (For diagrams see Pellmyr 1986). Staminodia typically fall off when dried so they are not present on herbarium specimens (Pellmyr 1986).

Distinguishing Characteristics

Cimicifuga rubifolia, C. racemosa, and *C. americana* all occur in the eastern U.S. Ramsey (1987) separated *C. rubifolia* from the other eastern species by the following diagnostic characteristics of *C. rubifolia*: 3-9 (rarely up to 17) leaflets; deeply cordate terminal leaflets with 5-9 prominent, basally-arising veins; 3 bracts subtending the pedicel; oblong fruits; and scaly, cylindrical seeds. Ramsey (1987) also reported that the absence of staminodia was a diagnostic characteristic; however, Pellmyr (1986) discovered staminodia on *C. rubifolia,* so this is no longer a valid distinguishing character for the eastern species. Ramsey (1986) determined that terminal leaflet mean lengths, widths, shape, and sinus depths can be used to delineate the eastern *Cimicifuga* species in vegetative conditions (Table 1).

Table 1. Comparison of the eastern North American species of *Cimicifuga* (Ramsey 1986).

Species	Terminal leaflet length (cm)	Terminal leaflet width (cm)	Sinus Depth (cm)	Shape of base: terminal leaflet
C. rubifolia	14.4	15.6	0.2-5.5 (normally 1.5-3)	cordate
C. americana	10.4	8.9	absent (occasionally to 0.5)	subcuneate
C. racemosa	10.5	8.1	absent (occasionally to 0.5)	subcordate

Kral (1983) and Kearney (1897) offer additional characteristics to distinguish these species and Ramsey (1988) explains how to delineate vegetative specimens of *Cimicifuga*, *Actaea, Astilbe*, and *Aruncus,* genera that are sometime confused.

LIFE HISTORY

Asexual Reproduction

Cimicifuga rubifolia possesses a rhizome that may branch and produce leaves along its length. Although the rhizome tends to be physiologically persistent, asexual reproduction by rhizome fragmentation rarely occurs (Cook 1993).

Sexual Reproduction

Cimicifuga rubifolia is self-incompatible and relies on insects, usually bumblebees (Hymenoptera) for pollination (Pellmyr 1986). *Milesia virginiensis* and other large- to medium-

sized syrphid flies (Diptera) may pollinate *C. rubifolia* but the rarity of these in the *C. rubifolia* populations makes these insects insignificant contributors to sexual reproduction. Several species of small beetles and flies visit the flowers but because they rarely touch the stigmas they are ineffective pollinators (Pellmyr 1986). Although some ecologists speculated that *C. rubifolia* may be wind pollinated due to the absence of nectar, Pellmyr (1986) determined this assumption is erroneous.

Apparently, there is a commensalistic relationship between *C. rubifolia*, *I. pallida*, and *P. canadensis*. The nectarless *C. rubifolia* is ineffective at attracting bumblebees and, apparently, relies on *I. pallida* and *P. canadensis*, both of which are prolific nectar producers, to attract pollinators. Bumblebees typically visit 5-10 *C. rubifolia* inflorescences before they visit either *Impatiens pallida* or *Polymnia canadensis* (Pellmyr 1986).

In *C. rubifolia*, a negative correlation occurs between fruit set and the distance to nectar, i.e., less fruit was produced at greater distances from either *I. pallida* or *P. canadensis*. In addition, *C. rubifolia* also declined at very close distances to the sources of nectar because the bees only visited one or occasionally two *C. rubifolia* inflorescences before returning to a nectar-producing species. The pollen of *I. pallida* is deposited on the backs of the bumblebees and probably does not mix with *C. rubifolia* pollen; however, it is possible that *C. rubifolia* and *P. canadensis* pollen may mix (Pellmyr 1986).

The flower of *C. rubifolia* consists primarily of sexual structures: the petals are absent and the sepals quickly fall off leaving numerous stamens and typically one carpel. Although the stamens and carpels mature at the same time, the species is self-incompatible (Pellmyr 1986). The flowers are sexually functional for two days. The flowers mature from the base of the inflorescence to the apex, with a maximum of 6-8 cm in open at any time. The primary inflorescence opens first, followed by the lateral ones (Pellmyr 1986). Staminodia usually produce odor in *Cimicifuga*, but in *C. rubifolia* the faint, sweet aroma is produced by an unidentified floral appendage (Pellmyr 1986).

Pellmyr (1986) reported a long flowering period (73 days) for *C. rubifolia* that extends from mid August to mid October with a peak in early September; however, Yatskievych (2000) and Mohlenbrock (2002) indicate that flowering begins as early as June and July in Indiana and Illinois, respectively. Fruiting occurs from late August to October (Pellmyr 1986).

The majority of plants do not flower each year and of the flowering plants, approximately 80% produce follicles with seeds (Cook 1993). Cook (1993) found that the percentage of flowering plants per year was variable ranging from 5-20%, but at least some of the variation may be due to climatic changes during her study. Also, the number of seedlings was variable ranging from 0 to more than 1000 (46% of the population). This variation in seedling production affected the percentage of flowering stems. At some populations the number of flowering plants remained constant but due to high seedling production, the percentage of flowering stems decreased (Cook 1993).

A number of plants had inflorescences that did not mature due to broken inflorescences, damage from herbivores, and death from unknown causes (Cook 1993), but overall, plant size is related

to sexual reproduction. Flowering plants are significantly larger than non-flowering plants, plants with more than one inflorescence are significantly larger than plants with one inflorescence, and larger plants produce more ovaries and follicles than smaller plants (Cook 1993).

Plant size also is related to dormancy and mortality. The majority of individuals are persistent from year to year; however, Cook (1993) determined that approximately ¼ of the individuals are absent for one or more years. Typically, an individual is dormant for one year, but some plants apparently may be dormant for at least 3 years. Plants that are persistent each year are significantly larger than plants that undergo dormancy or die (Cook 1993). Although smaller plants are more likely to die or become dormant, size-independent deaths also occur. Cook (1993) reported plant mortality from an uprooted tree and from flooding.

Flowering individuals that set fruit have been reported at 45% (Pellmyr 1986) and 80% (Cook 1993). Apparently, periods of excessive rain result in lower fruit set (Pellmyr 1986) and the abnormally dry conditions during Cook's study may have contributed to the differences in fruiting. There was a significant negative correlation between number of flowers per ramet and fruit set, i.e., as the number of flowers per ramet increased the fruit set decreased (Pellmyr 1986).

Size Class Distributions

Cook (1993) determined that the mean size of individuals increased during her study, but most individuals were in the smaller size classes. Some of the larger individuals showed a continued decrease in size and production of ramets, flowers, and follicles. She suggested *C. rubifolia* may reach a critical maximum size then gradually decrease in size until death or they may experience cyclic size changes. Perhaps individuals increase in size, and therefore sexual reproduction, then experience periods of smaller size and reduced fecundity (Cook 1993). It was not determined if climatic factors contributed to the change in size and the subsequent variation in fecundity. Size may not be a good indication of plant age if older plants decrease in size (Cook 1993).

Plant size also appears to affect the development of shoots from the rhizome. Apparently there is a critical minimum size necessary for the rhizome to develop more than one shoot (Cook 1993). In individuals with 1 or 2 ramets, there is a direct correlation between plant size and number of shoots; however, rhizomes with more than 2 ramets increased in size regardless of number of shoots. Cook (1993) suggested that once a minimum size is attained other factors influence plant size.

It appears that a critical minimum size is necessary for individuals to flower but other factors, such as precipitation, also may influence flowering (Cook 1993). It is unknown if flower primordia develop the year of flowering or the previous year when new shoot primordia develop. In spring after leaf development, some individuals develop minute flower primordia that do not mature suggesting that flower and leaf primordia develop at the same time (Cook 1993). Pellmyr (1986) also, reported inflorescence primordia on the lower stems of some *C. rubifolia*. Under normal conditions these primordia died but when the primary inflorescence was grazed, one or more of the primordia developed and flowered late in the season (Pellmyr 1986).

Seed Production and Germination

Seed production in *C. rubifolia* varies depending on the number of flowering plants and to a lesser extent, the number of follicles produced (Cook 1993). The seeds undergo epicotyl dormancy, i.e., they are 2-year seeds. Although the seeds germinate (produce radicals) in suitable environmental conditions, the epicotyls must be subjected to low temperatures before emergence (Cook 1993, Baskin and Baskin 1998). If the seeds experience low temperatures before germination, the radicals will not emerge until temperatures increase and the epicotyls do not emerge until subjected to a second cold period (Cook 1993, Baskin and Baskin 1998).

At times follicles do not dehisce until after the first frost, which results in seed dormancy and, subsequently, 2 cold periods are needed for shoot development. Occasionally, some seeds may germinate earlier in the growing season and only one winter is needed for epicotyl emergence (Cook 1993). It appears that seedlings survival increases in areas with little or no litter (Cook 1993). Seed dispersal may occasionally occur by water but the primary means of dispersal is gravity (Cook 1993).

Population Genetics

Although *C. rubifolia* is rhizomatous, cloning typically does not occur and sexual reproduction may be the only form of reproduction in most populations (Cook 1993). The high number of homozygous individuals indicates that inbreeding is common or populations are divided into small breeding groups with differing allele frequencies between the groups (Cook 1993). In addition, there is a high level of genetic divergence among *C. rubifolia* populations (Cook 1993).

In the majority of populations, clusters of *C. rubifolia* are within pollinator flight range of each other; however, pollinators may not fly between the clusters. The pollinators usually visit *Impatiens pallida* and/or *Polymnia canadensis* after leaving *C. rubifolia* rather than visiting another cluster of *C. rubifolia*. This pollination pattern helps to isolate the *C. rubifolia* clusters and limits more long distance pollination (Cook 1993).

Seed dispersal is primarily by gravity, which results in clusters of siblings in close proximity. Oftentimes seedling clusters are found approximately the distance of a flowering stalk length from supposedly the parent plant, i.e., a large flowering plant (Cook 1993). This dispersal mechanism contributes to the production of plant clusters with gene frequencies different from other groups within the population (Cook 1993). Another possible means of seed dispersal is water since many populations occur along streams; however, Cook (1993) only found one instance in which this may have occurred.

The genetic analyses support the field observations of no reproduction by rhizome fragmentation. In addition, in most populations, individuals are geographically arranged so that asexual reproduction is not probable, i.e., the individuals often are more widely spaced than typical clonal plants and exposed rocks limit rhizome growth (Cook 1993).

Because only 5-20% of a population flowers each year, Cook (1993) suggested that there probably is a large amount of breeding between closely related plants. For an animal-pollinated species, *C. rubifolia* has a very low amount of heterozygosity. There appears to be limited gene flow between the populations and the majority of genetic variation apparently comes from genetic drift and the presence of rare alleles in a few populations (Cook 1993). In addition, *C. rubifolia* may have a faster "genetic turnover" than other long-lived herbaceous perennials. Many assume that such species require years before they undergo sexual reproduction; however, new *C. rubifolia* ramets may flower in 2 years (Cook 1993).

The presence of a rare allele in the disjunct populations in Kentucky, Illinois, and Tennessee and its absence in the main populations indicates this allele arose after the disjunct populations were isolated from the central ones (Cook 1993). Genetically, *C. rubifolia* is most closely related to *C. elata* and *C. arizonica*, western North American species (Cook 1993, Compton *et al*. 1998). The large number of unique alleles in each North American *Cimicifuga* species and the relatively low genetic identity between species indicate that the North American species have been isolated from each other for a long time (Cook 1993) and should be considered distinct species. Compton *et al*. (1998) also showed extremely close genetic affinity between *Cimicifuga* and *Actaea* but did not suggest nomenclatural changes, although Kartesz and Meacham (1999) recognize *Actaea rubifolia* as synonymous with *C. rubifolia*.

HABITAT

Cimicifuga rubifolia typically occupies cool, moist, north-facing slopes in relatively undisturbed mesic forests at elevations of 270-480 m (sometimes up to 900m) in areas that were never glaciated during the Pleistocene (Ramsey 1965, Cook 1993, NatureServe 2001). These slopes often occur near rivers and streams but the species almost always is found above the high-water line, although it has been found on a floodplain and adjacent slope in Tennessee (Ramsey and Chester 1981, Miller 2000). It also may occur on limestone talus slopes, river bluffs, ravines, coves (Small 1933, Gleason 1963, Ramsey 1964, Ramsey 1965, Chester 1975, Keener 1977, Cook 1993, Grimm 1993, Flora of North America Editorial Committee 1997, Ketzner and Karnes 1998, Miller 2000). Only one reference indicates that it may be found in open woods (Kral 1983).

The species often is associated with limestone or calcareous shale, but at times it may be found on sandstone (Ramsey 1965, Ramsey and Chester 1981, Kral 1983, Medley 1993, Flora of North America Editorial Committee 1997). It often occurs on clay soils over calcareous rock (Ramsey 1965, Cook 1993), but it has been found on a rich, well-drained, loamy soil (Kral 1983). In Illinois, the soils typically are high in calcium and magnesium (Miller 2000). Soil pHs range from 5.1 to 7.2 in southern Illinois (Miller 2000), although Ramsey (1965) reported pH values to be less variable (6.2 to 6.7) further east.

Cimicifuga racemosa may be found growing with *C. rubifolia*, especially at lower elevations; however, *C. rubifolia* and *C. americana* are not sympatric (Ramsey 1965). Because *C. racemosa* flowers in summer whereas *C. rubifolia* flowers in fall, the 3 eastern species of *Cimicifuga* are

either geographically or temporally isolated so that interspecific pollination does not occur (Ramsey 1965).

Impatiens pallida and/or *Polymnia canadensis* often are found growing with *C. rubifolia* (Pellmyr 1986, Miller 2000) and these species play an important role in attracting pollinators for *C. rubifolia* (Pellmyr 1986).

DISTRIBUTION AND STATUS

Cimicifuga rubifolia is classified globally as G3 indicating that it is "generally to significantly rare throughout its range" (NatureServe 2001). The species was petitioned for federal status but lacked sufficient information to be listed. The center of distribution is the southern Appalachians with disjunct populations in Indiana, Illinois, Kentucky, and Pennsylvania (Figure 1). The species is found most abundantly in Tennessee and Illinois (Miller 2000). State Heritage Status Rank is as follows:

Alabama	SH	possibly extirpated
Illinois	S2	imperiled (endangered)
Indiana	S1	critically imperiled
Kentucky	S2	imperiled
Pennsylvania	SE	exotic
Tennessee	S3	vulnerable
Virginia	S2	imperiled

In addition, the U.S. Forest Service classifies *C. rubifolia* as a Regional Forester Sensitive Species (RFSS) on the Shawnee National Forest. Although the species in endangered in Indiana, it is not a RFSS on the Hoosier National Forest because it has not been found in that part of the state.

Illinois

Miller (2000) identified 26 populations of *C. rubifolia* in the Shawnee Hills Natural Division in extreme southern Illinois (Figure 2). Populations ranged in size from 8 ramets to almost 5000 ramets with the average number of adults/population 384 (std = 698) and the average number of juvenile ramets/population 257 (std = 800) (Miller 2000). The mean number of adult flowering plants was 27 (std = 24).

The Illinois populations occupy steep slopes (mean slope percent of 30, std = 10) in closed mesic forests (average canopy coverage of 88 percent). The soils at these sites are high in calcium and magnesium, shallow (depth ranges from 4-12 cm), and acidic to slightly neutral (pHs range from 5.1 to 7.2) (Miller 2000). Associated species include *Acer saccharum, Asarum canadense, Lindera benzoin, Parthenocissus quinquefolia, Carya cordiformus, Staphylea tripholia, Hybanthus concolor, Dioscorea quaternata, Asimina triloba, Sanicula canadensis, Actaea*

pachypoda, *Impatiens pallida*, and *Polymnia canadensis* (Miller 2000). (For a complete list of associated species for each Illinois population see Miller 2000 and Cook 1993.)

Indiana

Ten populations of *C. rubifolia* occur in two southern Indiana counties (Indiana Department of Natural Resources 2003) (Figure 3). Eight of these populations have been discovered in the past decade and the remaining two populations have not been observed since the mid 1980s (Indiana Department of Natural Resources 2003). Eight of the populations consisted of less than 100 individuals when last surveyed and six of these had 10 or fewer plants, including the two populations that have not been observed recently. The populations occupy positions on mid to lower north-facing slopes of mesic forests in shaded conditions. At four sites the observers suggested that additional plants may be present. At least some plants in flower were observed at five of the populations (Indiana Department of Natural Resources 2003).

In one location, a very large population of *Hedera helix* (English Ivy) threatens the three *C. rubifolia* plants, although this is one of the populations in which observers suggested additional *C. rubifolia* individuals may be present. At one of the sites not recently observed, a large *Fagus grandifolia* tree had fallen within a year before the last survey. At that time it was noted that some of the plants were "quite large" but the impact of tree fall on *C. rubifolia* has not been documented (Indiana Department of Natural Resources 2003).

POTENTIAL THREATS

Kral (1983) suggested that the major threat to *C. rubifolia* is logging and the subsequent soil erosion, especially on highly erodable slopes on which the species often occurs. In one population, a treefall resulted in the expansion of *I. pallida* and *P. canadensis* so that *C. rubifolia* was engulfed or grew along the very edge of the stand (Pellmyr 1986). In addition, Cook (1993) reported the loss of individuals due to an uprooted tree in another population, although some plants rerooted and survived the disturbance. However, in one Illinois population that was recently logged, flowering was exceptionally high (Miller 2000). Without additional monitoring of this site, it is not feasible to determine the long-term effects of this disturbance and if the increased flowering was a direct result of logging.

Predators of *C. rubifolia* include larvae of *Eupithecia cimicifugata* (Lepiodoptera), which have consumed inflorescences, unripe seeds, and ramets (Pellmyr 1986). Grazing, probably by cattle, is a problem in some populations (NatureServe 2001), although it was suggested that cattle probably would not be present on the steep slopes often occupied by *C. rubifolia* (Kral 1983). Trampling by grazer is a potential threat to the species (Kral 1983).

Other threats include competition from an exotic species, *Hedera helix*, in Indiana (Indiana Department of Natural Resources 2003) and "invasive weedy species" threaten some C. rubifolia populations in degraded habitats in the southern Appalachian (NatureServe 2001). Human activities including urbanization and dam construction have destroyed *C. rubifolia* habitat and

individuals in Tennessee and Virginia (Ramsey and Chester 1981, NatureServe 2001). Natural flooding also has killed plants due to inundation and water-saturated soils (Cook 1993). Miller (2000) reported ATV and equestrian damage in Illinois.

Several species of Cimicifuga are cultivated as ornamentals (Flora of North America Editorial Committee 1997) but this author found no evidence of C. rubifolia being collected or propagated as a nursery plant. Although *C. racemosa*, which shares the common name of black cohosh with *C. rubifolia,* is a common medicinal herb, there is no evidence that *C. rubifolia* is used medicinally.

RESTORATION POTENTIAL

The restoration potential of *C. rubifolia* is not known and there appear to have been no efforts to restore the species to favorable habitats. Reproduction is almost exclusively sexual although seed and seedling production is extremely variable (Cook 1993). Cook (1993) suggested that the production of numerous seedlings should be sufficient to maintain the populations even if reproduction was sporadic (Cook 1993). She also suggested that precipitation may have a lag effect on plant size and subsequently, reproduction.

RESEARCH AND MONITORING

Research is needed to accurately determine the status of *C. rubifolia*. For example, Miller (2000) found 26 populations in seven Illinois counties; however, before his work populations were only known from four counties (Illinois Department of Natural Resources 2003). Currently, information is needed for many of the populations, some of which have not been observed since the 1960s (NatureServe 2001). Monitoring of the populations should begin so that population trends can be determined and threats, such as grazing, logging, and competition from invasive species, can be ascertained.

REFERENCES

Baskin, C. C. and J. M. Baskin. 1998. Seeds: Ecology, biogeography, and evolution of dormancy and germination. Academic Press. San Diego. 666 pp.

Chester, E. W. 1975. Range extensions and first reports for some Tennessee vascular plants. Castanea 40: 56-63.

Compton, J. A., A. Culham, J. G. Gibbings, S. L. Jury. 1998. Phylogeny of *Actaea* including *Cimicifuga* (Ranunculaceae) inferred from nrDNA ITS sequence variation. Biochemical Systematics and Ecology 26:185-197.

Cook, R. A. 1993. The population biology and demography of *Cimicifuga rubifolia* Kearney and the genetic relationships among North American *Cimicifuga* species. Dissertation. University of Tennessee. Knoxville. 161 pp.

Fernald, M. L. 1950. Gray's manual of botany, 8th ed. American Book Co. New York. 1632 pp.

Flora of North America Editorial Committee. 1997. Flora of North America north of Mexico, Vol. III. Oxford University Press. New York. 590 pp.

Gleason, H. A. 1963. The new Britton and Brown illustrated flora of the northeastern U. S. and adjacent Canada, Vol II. Hafner Pub. Co, Inc. New York. 595 pp.

Gleason, H. A. and A. Cronquist. 1991. Manual of vascular plants of northeastern U. S. and adjacent Canada, 2nd ed. New York Botanical Garden. Bronx, NY. 910 pp.

Grimm,W. C. 1993. The illustrated book of wildflowers and shrubs. Revised by J. T. Kartesz. Stackpole Books. Harrisburg, PA. 637 pp.

Indiana Department of Natural Resources. 2003. Division of Nature Preserves Database. Indianapolis, IN.

Kartesz, J. T. and C. A. Meacham. 1999. Synthesis of the North American flora. North Carolina Botanical Garden. Chapel Hill. CD-ROM.

Kearney, T. H., Jr. 1897. New or otherwise interesting plants of eastern Tennessee. Bulletin of the Torrey Botanical Club 24:560-575.

Keener, C. S. 1977. Studies of the Ranunculaceae of the southeastern United States. VI. Miscellaneous genera. Sida 7:1-93.

Ketzner, D. and J. Karnes, eds. 1998. Illinois Plant Information Network: *Cimicifuga rubifolia*. Illinois Natural History Survey. Champaign, IL, USA. Retrieved February 12, 2003. http://www.fs.fed.us/ne/delaware/ilpin.

Kral, R. 1983. Ranunculaceae: *Cimicifuga rubifolia* Kearney. A report on some rare, threatened, or endangered forest-related vascular plants of the South. U.S. Forest Service Technical publication R8-TP2. Atlanta, GA. Vol I. 718 pp.

Medley, M. E. 1993. An annotated catalog of the known or reported vascular flora of Kentucky. Ph.D. dissertation. University of Louisville. 2595 pp.

Miller, T. R. 2000. Status of *Cimicifuga rubifolia* Kearney, black cohosh or Appalachian bugbane, in Illinois, 1999. Unpublished report to the Illinois Department of Natural Resources Wildlife Preservation Fund 1999-2000.

Mohlenbrock, R. H. 2002. Vascular flora of Illinois. Southern Illinois University Press. Carbondale. 490 pp.

NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 6.1. Arlington, VA, USA: NatureServe. Available: http://www.natureserve.org/explorer. Accessed July 11, 2002.

Pellmyr, O. 1986. The pollination ecology of two nectarless *Cimicifuga* sp. (Ranunculaceae) in North America. Nordic Journal of Botany 6:713-723.

Ramsey, G. W. 1964. Note on *Cimicifuga rubifolia* Kearney in Virginia. Rhodora 66:135.

Ramsey, G. W. 1965. A biosystematic study of the genus *Cimicifuga* (Ranunculaceae). Dissertation. University of Tennessee. Knoxville. 265 pp.

Ramsey, G. W. 1986. A biometrical analysis of terminal leaflet characteristics of the North American *Cimicifuga* (Ranunculaceae). Virginia Journal of Science 37:3-8.

Ramsey, G. W. 1987. Morphological considerations in the North American *Cimicifuga* (Ranunculaceae). Castanea 52:129-141.

Ramsey, G. W. 1988. A comparison of vegetative characteristics of several genera with those of the genus *Cimicifuga* (Ranunculaceae). Sida 13:57-63.

Ramsey, G. W. and E. W. Chester. 1981. The occurrence of *Cimicifuga rubifolia* Kearney in the Interior Low Plateaus Province of Tennessee. Castanea 46:100-101.

Small, J. K. 1933. Manual of the southeastern flora. Science Press Printing Co. Lancaster, PA. 1554 pp.

Yatskievych, K. 2000. Field guide to Indiana wildflowers. Indiana University Press. Bloomington. 357 pp.

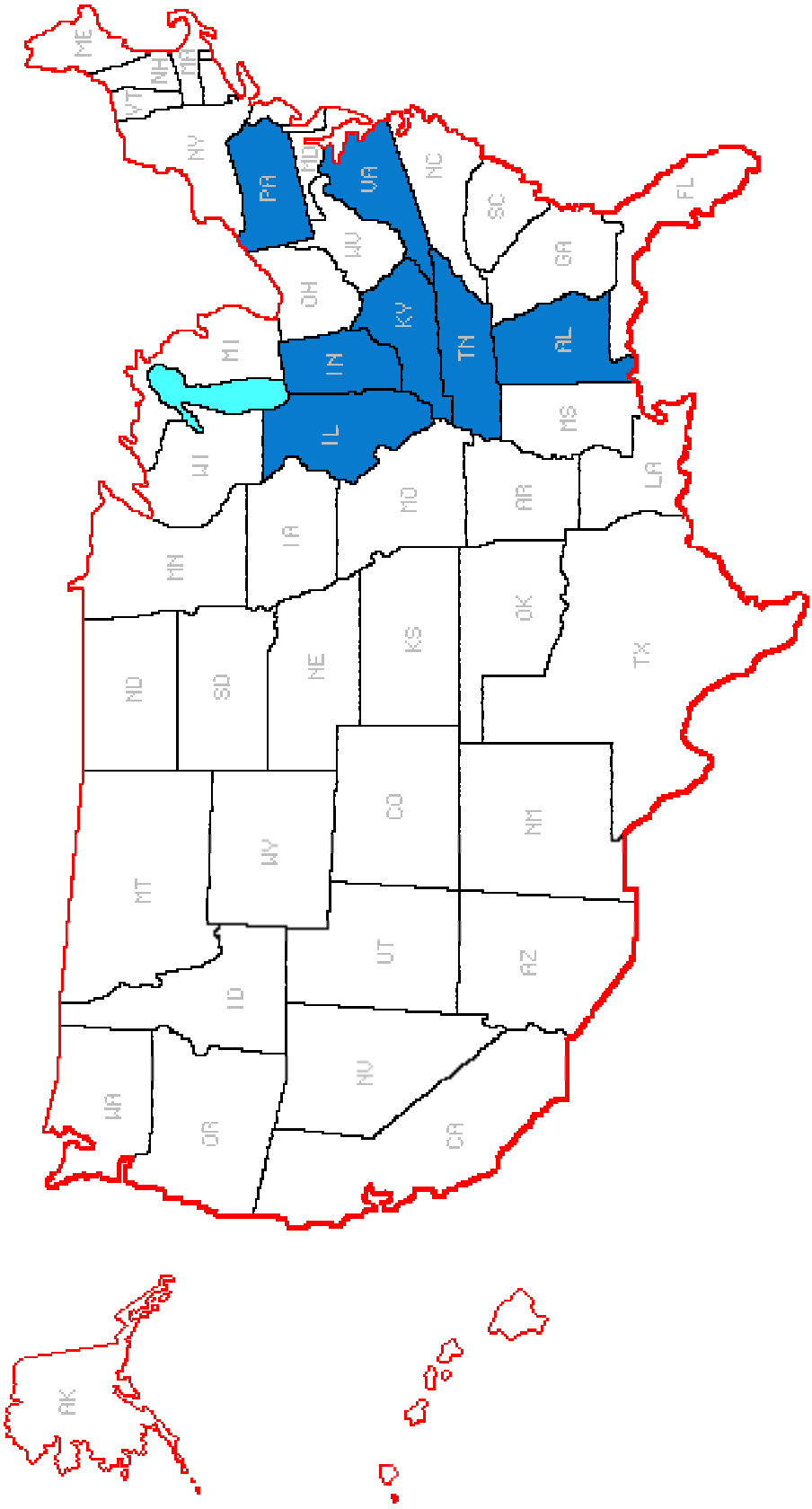

Figure 1. Distribution of *Cimicifuga rubifolia* in the U.S. (NatureServe 2001).

Figure 2. Distribution of *Cimicifuga rubifolia* in Illinois. Circles indicate counties with extant populations (Illinois Department of Natural Resources 2003).

Figure 3. Distribution of *Cimicifuga rubifolia* in Indiana. Circles indicate counties with extant populations (Indiana Department of Natural Resources 2003).