Conservation Assessment
for
Blue Monkshood (Aconitum uncinatum L.)

Photo by Steve Olson

USDA Forest Service, Eastern Region

August 2003

Alice Long Heikens, Ph.D.
Franklin College

Hoosier National Forest

This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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.

Table of Contents

EXECUTIVE SUMMARY

Aconitum uncinatum L. is a showy member of Ranunculaceae found in rich deciduous forests primarily in the Appalachian Mountains with disjunct populations in Indiana and Missouri. Globally, the species is ranked as G4 indicating that it is widespread and abundant, but The Nature Conservancy lists it as critically imperiled in a number of states including Illinois, Indiana, and Missouri, and it is a Regional Forester Sensitive Species on the Hoosier National Forest. Deforestation of mesic woods appears to have contributed to the demise of the species, which typically occurs in rather small, isolated populations. Damaged plants may reproduce asexually by bulbils, but the majority of plants throughout its range have not been observed in flower or producing seeds recently. It has been suggested in some locations that lack of flowering is due to heavy shade. The species typically is outcrossed by bumblebees, but plants are also self-compatible. It appears that *A. uncinatum* is not as toxic as other species of *Aconitum*.

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 *Aconitum uncinatum* 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.

ACKNOWLEDGEMENTS

I sincerely thank Steve Olson for review of this conservation assessment. George Yatskievych (Missouri Botanical Gardens), Timothy Smith (Missouri Department of Conservation), and Robert Goffried (Illinois Natural History Survey) provided valuable information on the species, in addition to the Illinois Department of Conservation and the Indiana Department of Natural Resources Division of Nature Preserves.

NOMENCLATURE AND TAXONOMY

Scientific Name: *Aconitum uncinatum* L.
Common Names: Blue Monkshood, Southern Monkshood, Clambering Monkshood, and Wild Monkshood.
Synonyms: *Aconitum uncinatum* subsp. *muticum* (DC) Hardin
Aconitum uncinatum var. *acutidens* Fernald.
Class: Dicotyledoneae

Order: Ranunculales
Family: Ranunculaceae

Aconitum is a northern, mountainous genus of Ranunculaceae that is closely related to *Delphinium* (Hardin 1965, Brink 1982). The aconites or monkshoods have a circumboreal distribution that extends into northern Africa and northern Mexico (Brink 1982). The center of diversity of the genus is the mountains of eastern Asia followed by the mountains of central Europe, western North American, and, finally, the eastern U.S. (Hardin 1964). In the U.S., the genus is divided into two major groups based on root characteristics, the majority of which are tuberous, including *A. uncinatum*. The tuberous monkshoods are extremely polymorphic (Brink 1982) and there has been much disagreement over how to divide this group taxonomically. The level at which morphological differences should be distinguished is not clear as evidenced by the various classifications used to delineate the taxa, i.e., species, subspecies, and varieties.

Hardin (1964) recognized two species of *Aconitum* in the eastern U.S., *A. reclinatum* and *A. uncinatum*. The later species was divided into three subspecies, *uncinatum*, *muticum*, and *noveboracense*, based on morphology, geography, and physiography. Of these three subspecies, *muticum* was determined to be intermediate between *uncinatum* and *noveboracense* (Hardin 1964).

Asa Gray named *A. noveboracense*, currently classified as a federally threatened species, a distinct species (Cole and Kuchenreuther 2001) but Hardin (1964) reduced it to a subspecies of *A. uncinatum*. Flora of North America Editorial Committee (1997) and Brink (1982) determined that *A. noveboracense* was more closely related to the western species, *A. columbianum*, and reduced it to a subspecies, i.e., *A. columbianum* subsp. *columbianum*. A molecular DNA study supports the similarity between *A. noveboracense* and *A. columbianum* and indicated that *A. uncinatum* differs from the other two taxa (Cole and Kuchenreuther 2001). Gleason and Cronquist (1991) recognized two varieties of *A. uncinatum*, *uncinatum* and *muticum*. However, Flora of North America Editorial Committee (1997) does not divide *A. uncinatum* into subspecies or varieties.

DESCRIPTION OF SPECIES

Plant	Herbaceous perennial.
Roots	tuberous, tubers not obviously bulblike, 10-30 (80) x 5-15 mm, parent tuber producing several (ca. 5) daughter tubers separated from parent by connecting rhizomes 5-30 mm.
Stems	slender, weak, erect, reclining, or climbing, often supported by other plants, 3-25 dm. long, glabrous.
Leaves	Cauline leaves glabrous, numerous, firm, deeply 3-5 palmately lobed into narrow or broadly rhomboid-ovate to ovate-lanceolate segments, usually with more than 2 mm leaf tissue between deepest sinus and base of blade, lowest leaves 4-10 cm

wide, the cauline leaves becoming smaller upward, segment margins irregularly and sharply few toothed or incised.

Inflorescence short, a few-flowered terminal raceme or open panicle. Flowers are typically dark purplish blue, but may also be pale, even within a population.

Sepals 5, petal-like, blue. The lower (pendent) 2 sepals oblique-elliptic, 7-18 mm long, widely spatulate. The upper sepals (called the hood or helmet) erect, broadly rounded-conical, compressed, prominently beaked in front, beak 5-9 mm long; 2.5-5 cm from tips of pendent sepals to top of hood, 15-27 mm from receptacle to top of hood (helmet), 13-24 mm wide from receptacle to beak apex.

Petals 5, blue, nectariferous at the tip; sepal hood conceals 2 small petals, the other 3 petals are minute or may be absent. The 2 concealed petals have nectar glands on their coiled tips.

Stamens numerous.

Pedicels or just their distal ends short hirsute to pilose with straight and spreading hairs, 0.8-2 cm long, glabrous below, densely pubescent at the summit.

Carpels 3, glabrous, pubescent, or glabrate.

Fruit follicle, turgid, (8)12-16 mm long, 5-6 mm broad, sparsely pubescent to glabrate.

Seeds yellowish, scaly, somewhat rectangular, 4 mm long, 2.5 mm broad.

(Small 1933, Fernald 1950, Gleason 1963, Hardin 1964, Strausbaugh and Core 1964, Radford *et al*. 1968, Gleason and Cronquist 1991, Flora of North America Editorial Committee 1997, Smith 1998, Yatskievych 2000).

Distinguishing Characteristics

Traditionally, the eastern species of *Aconitum* have been distinguished by flower color, pubescence on the inflorescence, leaf lobing, plant habit, and shape of the hood (upper sepal) (Hardin 1964). *Aconitum reclinatum* is quickly distinguished from the other eastern species by their slender, fascicled roots and whitish flowers versus the thick tubers and blue flowers of *A. uncinatum*.

Hardin (1964) determined that the following characteristics are not reliable for distinguishing among the various monkshoods: plant habit, shape of the leaf base, and form of the inflorescence. He suggested that habit was due in part to environmental factors because plants in more open areas often were shorter and more erect than plants in more crowded or shaded areas, which were taller and weaker, reclining, or twining. Additionally, the smaller, more erect plants

had flowers arranged in terminal racemes, whereas the larger plants developed inflorescences of open panicles.

There is tremendous variation in the leaves on an individual plant (Hardin 1964). The basal and lower cauline leaves are usually large and deeply lobed, but because these are seldom collected or illustrated their characteristics are not commonly known. Shape of the leaf base oftentimes varies from truncate to cordate or hastate, along with a variety of intermediates even on one plant (Hardin 1964). Foliar anatomy, however, was useful in delineating taxa and Hardin (1964) speculated that the size and shape of vein islets may become an important taxonomic characters.

Hardin (1964) determined that several reproductive features were good taxonomic characters. Flower color in *A. uncinatum* varies from dark blue-purple to very pale blue, with some populations having quite uniform color and others expressing more variation. He suggested the variation may be due to exposure to light, age of the plant, or genetic differences. Other consistent differences that helped to delineate taxa included shape, size, and pubescence of the floral parts, follicles, and seeds (Hardin 1964). However, Hardin considered the shape of the hood to be the most useful taxonomic character although the shape of *A. uncinatum* may vary from arched to conic-hemispheric and shapes may or may not be consistent within a population. Although Hardin (1964) found the three subspecies to be somewhat distinct morphologically, he determined that the taxa apparently are not reproductively isolated but intergrade freely.

Brink (1982) determined that the tubers of *A. uncinatum* tasted more bitter than *A. noveboracense* or *A. columbianum*, but due to the potential toxicity of the monkshoods, this is not a good means to distinguish taxa. Although tuber morphology is a useful taxonomic trait, rarely are daughter tubers present on herbarium specimens because they are easily lost when the plant is collected (Brink 1982, Flora of North America Editorial Committee 1997). *Aconitum uncinatum* can be delineated from *A. noveboracense* (a.k.a. *A. columbianum* subsp. *columbianum*) by the several daughter tubers that are separated from the parent by connecting rhizomes of 5-30 mm in *A. uncinatum* versus the typical single daughter tuber with a very short or continuous rhizome in *A. noveboracense* (Flora of North America Editorial Committee 1997).

LIFE HISTORY

Evolution

Aconitum is the most evolutionarily advanced genus of Ranunculaceae based on flower morphology and karotype (Brink 1982); however, Leppik (1964) considered the flowers to be rather primitive in comparison to some of the zygomorphic species in Scrophulariaceae. Hardin (1964) postulated that *A. uncinatum* and *A. noveboracense* may have been allopatric species before the Pleistocene. During the Pleistocene, *A. noveboracense* migrated south and crossed with *A. uncinatum* to produce hybrids that formed the intermediate form, i.e. *A. uncinatum* subsp. *muticum*. When the glaciers retreated, *A. noveboracense* migrated north and the two subspecies of *A. uncinatum* remained primarily in the Appalachians. He also speculated that the three subspecies could be ecotypes that arose by incomplete speciation from one widespread ancestral population.

Iltis (1965 in Cole and Kuchenreuther 2001), in addition to Brink (1982) and Flora of North America Editorial Committee (1997), considered *A. noveboracense* to be disjuncts from *A. columbianum* and suggested that at the end of the Pleistocene the ancestor of *A. noveboracense* was probably common along the glacial margin (Cole and Kuchenreuther 2001). As the glaciers retreated, the taxon survived in cool, moist microenvironments that were similar to the mountainous and periglacial environments occupied by other monkshoods (Cole and Kuchenreuther 2001).

Leppik (1964) suggested that *Aconitum* co-evolved with the ancestors of the present-day bumblebees and reported that the distribution of *Aconitum* is entirely within the distribution of bumblebees.

Asexual Reproduction

In some *A. uncinatum* populations, a few individuals, especially those that have been damaged, may produce bulbils in the leaf axils (Brink 1982). These bulbils are persistent and root while still attached to the stem. This is in contrast to the bulbils of *A. columbianum* that are deciduous late in the growing season (Brink 1982).

Sexual Reproduction– Pollination

Aconitum uncinatum typically is an outcrosser pollinated by bumblebees (Leppik 1965, Brink 1981, 1982). The blue, zygomorphic flowers exhibit characteristics that support this relationship including a sturdy landing platform, numerous stamens near the flower entrance that attract bees, flower morphology that corresponds to the size and shape of bees, trichomes in the flower that deposit pollen on the bees, and nectaries embedded deep into the flower (Leppik 1964, Brink 1981). The nectaries are found on petals that are enclosed within the hooded sepals (Leppik 1964). Guidelines help the bee find the nectar after crawling over the stamens and pistils (Brink 1981). The sepals now function to attract pollinators since the petals either degenerated or are enclosed within the sepals (Leppik 1964).

Aconitum is protandrous, i.e., the stamens mature before the carpels are receptive to pollen (Brink 1981). This results in functionally male flowers that shed pollen and later, functionally female flowers develop. Additionally, flowers mature from the bottom of the inflorescence to the top so that in a mature inflorescence, the lower flowers are functionally female and the upper ones male. As the flowers mature they produce larger amounts of nectar, i.e., the lower flowers secrete more nectar than the upper ones.

According to Brink (1981), bumblebees typically visit the lower flowers with greater amounts of nectar and move successively higher in the inflorescence. As they do this, they move from functionally female flowers to functionally male flowers. However, they tend to leave the inflorescence before visiting all of the flowers in one inflorescence due to the decreased amounts of nectar found on the upper flowers. This effectively ensures outcrossing because the bees then

fly to another inflorescence and begin foraging at the bottom on the new inflorescence in the functionally female flowers. This floral arrangement and production of nectar is beneficial to the bumblebees because this is the most efficient foraging pattern for gathering nectar (Brink 1981).

Because outcrossing is essentially ensured, *Aconitum* has not developed genetic barriers to prevent self-fertilization and the genus is self-compatible (Brink 1981). Leppik (1964) reported that beetles and flies often visit *Aconitum* flowers but are not able to pollinate the species or obtain the nectar.

Aconitum uncinatum seeds are relatively heavy and probably do not disperse well (Olson 2003). In 10 years of monitoring an Indiana population in which some plants are located in full sun and others in dense shade, very few follicles were observed (Olson 2003).

Chromosomes

Aconitum uncinatum (2n = 16) has 8 distinct chromosomes with a total chromosome length of 103 microns (Longacre 1942). The 4 long and 4 short chromosomes range in size from 3.2 to 9.2 microns. There is no evidence of variation in the chromosome number in individuals in the species. Longacre (1942) assumed "normal meiotic behavior" of the species because they set seed freely in their native habitats. For additional information on meiosis in *A. uncinatum* see Jensen (1950).

Toxicity

The monkshoods have been studied for hundreds of years because of their toxicity (Hardin 1964). Although *A. uncinatum* has been described as poisonous and is said to contain the same alkaloids as other monkshoods (Westbrooks and Preacher 1986, Pammel 1992), Brink (1982) stated the diterpene alkaloids vary in structure among the species and range from extremely poisonous to relatively non-toxic. According to Westbrooks and Preacher (1986), the plant is most toxic before flowering and the root is the most poisonous part of the organism. They stated that 2-4 mg was the lethal dose for humans; however, Brink (1982) ate small amounts of *A. uncinatum* without suffering any ill effects. He, therefore, suggested that *A. uncinatum* is not as toxic as some of the monkshoods. Additionally, Brink (1982) nor this author found any references to bioassays to determine the toxicity of *A. uncinatum*. It appears that the references to toxicity are based on the genus and inferred to the species.

Although *A. columbianum*, found in the Rocky Mountains has killed livestock that graze in the upper altitudes (Pammel 1992), Hardin (1964) suggested that *A. uncinatum*, due to its woodland habitat and relatively small, infrequent populations, does not pose as serious treat to animals as *A. columbianum*.

HABITAT

The most common habitat for *A. uncinatum* is rich deciduous woods often along streams or other moist areas such as damp slopes (Fernald 1950, Hardin 1964, Strausbaugh and Core 1964, Radford *et al*. 1968, Medley 1993, Flora of North America Editorial Committee 1997, Smith 1998). The species is found primarily in the Appalachian Mountains, on the Piedmont, and on the upper Atlantic Coastal Plain at elevations of 200-2000m (Hardin 1964, Flora of North America Editorial Committee1997). In Ohio, the species is found in deep shade of a cool, moist sandstone rock shelter in a mesic cove with an east exposure (Cusick 1983, McCance and Burns 1984). Flora of North America Editorial Committee (1997) indicates that it may be located in less mesic areas in woods and clearings. Deam (1940) verified its historic location on the barrens in southern Indiana; however, it is unclear if this was in a barrens community or the barrens region of the state. The herbarium label information mentions only the "barrens of Indiana" (Olson 2003).

Associated Species

In Ohio, *A. uncinatum* is found growing with *Betula alleghaniensis, Fagus grandifolia, Tsuga canadensis, Circaea aplina, Cystopteris bulbifera, Dryopteris marginalis,* and abundant liverworts including *Marchantia polymorpha* (Cusick 1983). In northern Illinois, associated species include *Acer saccharum, Allium cernuum, Amphicarpaea bracteata, Anemonella thalictroides, Antennaria plantaginifolia, Carex pensylvanica, Crataegus mollis, Dioscorea villosa, Geranium maculatum, Juglans nigra, Ostrya virginiana, Podophyllum peltatum, Polygonatum canaliculatum, Potentilla simplex, Quercus alba, Q. macrocarpa, Q. rubra, Sanguinaria canadensis, Smilacina racemosa, Tilia americana,* and *Viburnum opulus* (Swink and Wilhelm 1994). At the edge of a native old field in Indiana associating with *A. uncinatum* are *Juniperus virginiana, Rhus copallina, Schizachyrium scoparium, Coreopsis tripteris, Silphium trifoliatum,* and *Aristida purpurascens* (Olson 2003).

DISTRIBUTION AND STATUS

Historic records indicate that *Aconitum* populations were more continuous and widespread than today (Hardin 1964). Hardin suggested that the monkshoods are not surviving the disturbance of habitats and are deceasing in abundance because they lack the ability to expand geographically although they express tremendous morphological diversity.

Aconitum uncinatum is primarily an Appalachian species with disjunct populations in such states as Missouri and Indiana (Figure 1). Globally, the species is ranked as G4 indicating that it is widespread and abundant but there is some concern about long-term status. In some states, such as North Carolina and Georgia, the species is more abundant; however, in several states including Illinois, Indiana, and Missouri, the taxon is critically imperiled. In addition, *A. uncinatum* is a Regional Forester Sensitive Species on the Hoosier National Forest in Indiana. State Heritage Status Ranks is as follows:

Alabama	S1	critically imperiled
Georgia	S3S4	vulnerable/apparently secure
Illinois	S1	critically imperiled
Indiana	S1	critically imperiled
Kentucky	S2	imperiled
Maryland	S1	critically imperiled
Missouri	S1	critically imperiled
New Hampshire	SR	state reported
North Carolina	S3S4	vulnerable/apparently secure
Ohio	S1	critically imperiled
Pennsylvania	S2	imperiled
South Carolina	S2	imperiled
Tennessee	S3?	vulnerable
Virginia	SR	state reported
West Virginia	S?	unranked

Illinois

Although there are some references to *A. uncinatum* in DuPage and Lake counties (Mohlenbrock 1986, Swink and Wilhelm 1994, Ketzner and Karnes 1998, Mohlenbrock 2002), the Illinois Department of Natural Resources has not verified any populations in the state (Gottfried 2002) and, therefore, the species is not state listed (Illinois Endangered Species Protection Board 1999). See Figure 2.

Indiana

Five extant populations of *A. uncinatum* are located in the Hoosier National Forest in extreme southern Indiana in Perry County (Figure 3). Four of the populations were discovered within the past three years; the remaining population has been known since 1989. Most of the populations consist of less than 10 plants, although at least one population has more than 100 individuals. The populations typically occupy lower north-facing slopes in mesic woods. Only two populations have been observed in flower; a few flowers were found on the plants in the population discovered in 1989 and, more recently, a number of plants flowered along one of the roadside populations (Olson 2003). An observer suggested that dense shade might be preventing flowering (Indiana Department of Natural Resources 2003).

Deam (1940) verified *A. uncinatum* herbarium specimens collected in the 1840s on the barrens in Harrison County, but the species has been extirpated from this location. Herbarium label information is too vague to determine the exact location of the species but most of the barrens region has been converted to agriculture and more recently, suburbs (Olson 2003).

Missouri

Two populations in Shannon County in the Ozark Natural Division were discovered in Missouri in 1997 (Smith 2002, Yatskievych 2002). See Figure 4.

Ohio

In Ohio, Cusick (1983) discovered 121 plants on a shaded sandstone cliff in a mesic forest. At this site, the majority of plants were immature and vegetative. The immature plants merely consisted of one or two basal leaves, while the mature plants possessed at least a few cauline leaves. Of the four plants with inflorescences, only two appeared to have successfully flowered – the others lacked flower buds. No seeds or bulbils were observed. Cusick (1983) suggested that the lack of reproduction here indicates the fragile nature of this population. *Aconitum uncinatum* is classified as state endangered in Ohio (Cusick 1983, McCance and Burns 1984).

POTENTIAL THREATS

Specific threats to *A. uncinatum* have not been identified; however, it has been suggested that in Ohio deforestation and the subsequent drying of the habitat may have destroyed some populations (Cusick 1983). The extant population may be a remnant that survived since it is found in a more mature region of the forest that has received less disturbance than adjacent ravines (Cusick 1983). McCance and Burns (1984) also suggested that the drying of this forest habitat by removal of the canopy and soil compaction exacerbates the fragile condition of the population.

In Indiana, the only flowering population of *A. uncinatum* occurs along a roadside with increased sunlight (Olson 2003) and it was postulated that dense shade may decrease flowering (Indiana Department of Natural Resources 2003). In Missouri, it has been suggested that *A. uncinatum* populations may have benefited from forest thinning by beavers. As a result, more light reaches the riverbank terrace and may have stimulated flowering (Smith 2002). The specific effects of forest thinning have not been determined, however, it appears that an intermediate condition may optimize flowering if soil compaction and excessive drying of the habitat does not occur. Understory shading and habitat fragmentation could also lead to a decline in pollinator populations and, thus, reduce sexual reproduction of the species (Olson 2003).

PAST AND CURRENT CONSERVATION ACTIVITIES

The restoration potential of *A. uncinatum* has not been documented; however, McCance and Burns (1984) postulated that the recovery potential for this species in Ohio is very low.

RESEARCH AND MONITORING

Aconitum uncinatum typically occurs as small, isolated populations and apparently never has been common (Hardin 1964). Therefore, it is imperative that the remaining populations are monitored to determine population trends and research be conducted to determine the optimal conditions for survival of the species.

REFERENCES

Brink, D. E. 1981. Biosystematic and ecological investigations on tuberous *Aconitum* (Ranunculaceae) of the United States. Ph.D. dissertation. University of Illinois. Urbana. 70 pp.

Brink, D. E. 1982. Tuberous *Aconitum* (Ranunculaceae) of the continental United States: morphological variation, taxonomy, and disjunction. Bull. Torrey Botanical Club 109:12-23.

Cole, C. T. and M. A. Kuchenreuther. 2001. Molecular markers reveal little genetic differentiation among *Aconitum noveboracense* and *A. columbianum* (Ranunculaceae) populations. American Journal of Botany 88(2):337-347.

Cusick, A. W. 1983. *Aconitum uncinatum* discovered in Ohio. Castanea 48:209-211.

Deam, C. C. 1940. Flora of Indiana. W. B. Burford Printing, Inc. Indianapolis, IN. 1236 pp. 1236.

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 I. 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.

Gottfried, B. 2002. Personal Communications. Illinois Natural History Survey. Urbana, IL.

Hardin, J. W. 1964. Variation in *Aconitum* of eastern United States. Brittonia 16:80-94.

Illinois Endangered Species Protection Board. 1999. Checklist of endangered and threatened animals and plants of Illinois. Illinois Department of Natural Resources. Springfield, IL. 20 pp.

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

Jensen, H. W. 1950. Meiosis in an unusual form of *Aconitum uncinatum* L. American Midland Naturalist 84:17-22.

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

Kartesz, J. T. 1994. A synonymized checklist of the vascular flora of the U. S., Canada, and Greenland, 2nd ed. Timber Press. Portland, OR. 622 pp.

Leppik, E. E. 1964. Floral evolution in the Ranunculaceae. Iowa State Journal of Science 39:1-101.

Longacre, D. J. 1942. Somatic chromosomes of *Aconitum noveboracense* and *Aconitum uncinatum*. Bull. Torrey Botanical Club 69:235-239.

McCance, R. M., Jr. and J. F. Burns. 1984. Ohio endangered and threatened vascular plants. Department of Natural Resources. Columbus, OH.

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

Missouri Natural Heritage Program. 2001. Missouri species of conservation concern checklist. Missouri Department of Conservation. Jefferson City, MO. 28 pp.

Mohlenbrock, R. H. 1986. Guide to the vascular flora of Illinois. Southern Illinois University Press. Carbondale, IL. 507 pp.

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.

Olson, S. 2003. Personal communications. Pike-San Isabel National Forest. Pueblo, CO.

Pammel, L. H. 1992. A manual of poisonous plants: chiefly of eastern North America, with brief notes on economic and medicinal plants and numerous illustrations. Lubrecht and Cramer. Forestburgh, NY. 977 pp.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press. Chapel Hill. 1183 pp.

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

Smith, R. M. 1998. Wildflowers of the southern mountains. University of Tennessee Press. Knoxville. 262 pp.

Smith, T. 2002. Personal communications. Missouri Department of Conservation. Jefferson City, Missouri.

Strausbauch, P. D. and E. L. Core. 1964. Flora of West Virginia. West Virginia University Bulletin. 1075 pp.

Swink, F. and G. Wilhelm. 1994. Plants of the Chicago region, 4th ed. Indiana Academy of Science. Indianapolis. 921 pp.

Westbrooks, R. G. and J. W. Preacher. 1986. Poisonous plants of eastern North America. University of South Carolina Press. Columbia. 226 pp.

Yatskievych, G. 2002. Personal communications. Missouri Botanical Gardens. St. Louis, Missouri.

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

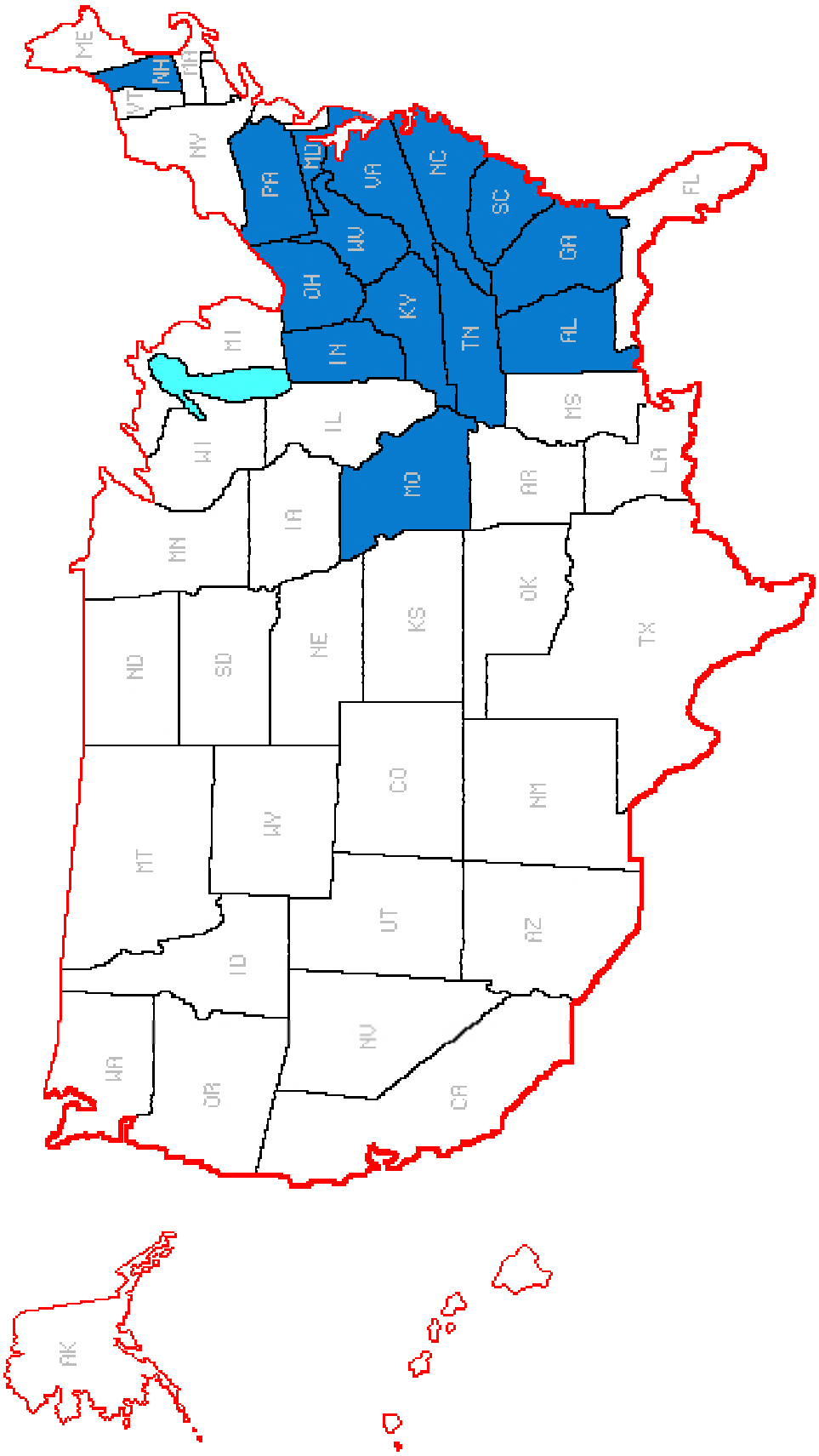

Figure 1. Distribution of *Aconitum uncinatum* in the U.S. (NatureServe 2001).

Figure 2. Distribution of *Aconitum uncinatum* in Illinois. Xx indicate counties with extirpated populations (Mohlenbrock 1986, 2002; Swink and Wilhelm 1994).

Figure 3. Distribution of *Aconitum uncinatum* in Indiana. Circles indicate counties with extant populations; Xs indicate counties with extirpated populations (Indiana Department of Natural Resources 2003).

Figure 4. Distribution of *Aconitum uncinatum* in Missouri. Circles indicate counties with extant populations (Yatskievych 2002).