Status of *Cimicifuga rubifolia* Kearney, Black Cohosh or Appalachian Bugbane, in Illinois, 1999.

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Taxon:

Cimicifuga rubifolia Kearney

Common Name :

Black Cohosh and Appalachian Bugbane (eastern states of occurrence).

Family :

Ranunculaceae

States of Occurrence :

Illinois, Kentucky, Indiana, Alabama, Tennessee, and Virginia (figure 1).

Current State Status :

Threatened

Recommended State Status :

Threatened

Description:

Cimicifuga rubifolia Kearney is a tall slender perennial herb, up to 1.5 meters tall, A single erect shoot originates from a knotted, irregularly horizontal rhizome. **Stems** are roundish in cross section, often maroon- tinted, usually smooth or with a villous-hairy line, usually unbranched or wand-like in flower. **Leaves** are few, concentrated toward the base of stem, petioles elongate, sheathing the stem-base, three branched, with each branch again three branched (ternate), the leaflets symmetrically or asymmetrically ovate to orbicular, prominently 3-5 lobed, as much as 7 lobed (resembling red maple in shape and outline) to 1.2 dm long on petioles slightly shorter, the lobe tips acuminate, the margins coarsely and irregularly serrate, the bases usually cordate, the upper surfaces deep green, smooth, the lower surfaces paler, smooth or with some long crisped hairs on the raised veins. **Inflorescence** is elongate, terminal openly cylindrical raceme of whitish flowers, the axis puberulent. **Flowers** are symmetrical, sepals 2-5, falling off when or shortly after the bud opens, ovate-suborbicular, yellowish-white, smooth, ciliate or entire. Petals absent. Stamens numerous, on a slightly elevated receptacle, the filaments white, filiform but slightly broadening upward, the anthers short, yellowish- white. Carpels no more than 2, sessile on receptacle. **Fruit** is asymmetrically oblong, 8-10 mm long, somewhat flattened, veiny, the numerous small seeds chaffy, in 2, irregular rows. (Kral 1983).

Demography for Entire Range:

States of occurrence are as follows: Alabama, Kentucky, Indiana, Illinois, Tennessee, and Virginia. Specific demographic information is found in table 5. Distribution by county in all states of occurrence is illustrated in figure 1.

Demography in Illinois:

Twenty six distinct populations have been found and described in seven

southern Illinois counties: Saline, Hardin, Gallatin, Jackson, Johnson, Pope, and Massac.

General Habitat:

Cimicifuga rubifolia was initially described by T.H. Kearney (1897). However, it was not generally accepted as a species until a study by Ramsey (Ramsey 1965). *C. rubifolia* is found throughout its range in large areas of relatively undisturbed, north to northeast facing slopes of mixed mesophytic forest (or similar habitat) within a larger hardwood forest . These sites frequently possess soils high in calcium and magnesium content (i.e., derived from calcerous shales, dolomite or limestone) (Kral 1983). It is often characterized through much of its range as being nearby rivers and streams, yet being high above the high water mark (Cook 1993). Illinois habitat has been specifically described as growing on sandstone and limestone in deep ravines (Ramsey 1993c in Ostlie 1994), while Mohlenbrock (1975) listed habitat for Illinois as "rich woods".

C. rubifolia is restricted to the Shawnee Hills Natural Division in Illinois. This region is found to run across the southern tip of the state from Fountain Bluff on the Mississippi to the Shawneetown Hills near the mouth of the Wabash River. It is unglaciated hill country that was primarily forested in pre-settlement times and remains fairly well forested today. The division is characterized by a high east-west running escarpment of sandstone cliffs forming the Greater Shawnee Hills, and a series of lower hills underlain by sandstone and limestone known as the Lesser Shawnee Hills (Schwegman et al. 1973). Soils are formed primarily loess derived with moderately developed deep loess soils infrequent. Most soils are derived from thinner loess and are strongly developed, with claypan and fragipan soils frequent (Schwegmen et al. 1973).

Threats:

Most sites were relatively stable. Threats to populations included ATV and equestrian traffic. Sites particularly vulnerable to this type of disturbance include the Jackson Hollow populations and Owl Bluff. Owl Bluff and the Jackson Hollow Railroad site are very vulnerable due to extremely small population size. Owl Bluff is additionally threatened by garbage dumping from the top of Owl Bluff, an extremely denuded horse campsite. The Jackson Hollow Natural Area population is in danger from trampling by equestrians. During three separate visits to the site the author found evidence of trampled plants each time. The Antioch Church site had been recently logged, however flowering rates were very high. This site should be monitored to determine the extent, if any, of damage caused by logging. Kral (1983) hypothesized this to be a ecologically devastating factor for populations.

Materials and Methods:

Populations of *Cimicifuga rubifolia* were located by field searches and using location descriptions found on element occurrence records in the Illinois Department of Natural Resources heritage biology program. Populations were considered to be metapopulations if found more than twenty five meters apart, but within a short enough

distance to allow geneflow between populations by pollinators. Thirty seven metapopulations were found under this classification and studied. Several populations found after the current study, while working with the Shawnee National Forest, are given population estimates, however no ecological measures were taken. Due to the clonal nature of the plant, individual stems were considered to be ramets. No attempt was made to determine the amount of genets due to the destructive consequences of digging around the plants in order to detect underground rhizome connections.

Individual populations with ramets numbering less than 250 individual were completely censussed. Populations greater than 250 individual ramets were estimated by first walking the outside perimeter of the entire population with a Garmin 12 GPS unit to measure the boundary. A smalller area was then measured in the same way. All ramets within this smaller area were counted. Total population size was then estimated using a simple conversion, (# ramets in small area/ x # ramets in large area) = (length of small area/ length of large area). GPS measurements were uncorrected.

Percent flowering was measured by first estimating the total amount of adult ramets. Adults were determined to be plants over twelve inches tall. Number of flowering adult ramets were then tallied within the metapopulation.

Soil assays were performed to include pH (Eckert 1988), phosphorous (Knudsen and Beegle 1988), potassium (Brown and Warncke 1988), and soil particle analysis (Sabey 1969).

Canopy density was measured with a spherical densiometer (Lemon 1956). The densiometer was leveled at the metepopulation center, and the reflection of the foliage was tallied in the four cardinal directions with the use of a mask.

Data analysis was performed using SAS.

Results:

Information found during the current census and previous estimates are provided on element occurrence records within the body of this report. A map is provided for most populations, however locations are uncorrected GPS readings. Thirty seven metapopulations were studied using the methods listed previously. These metapopulations made up twenty one distinct populations.

Population size ranged from 8 ramets (Jackson Hollow Railroad site) to 4858 ramets (Eddyville Bridge). Average number of juvenile ramets for all populations was 257.27 ± 800.83 std (table 2). Mean number of adults was 383.64 ± 697.61 std. Mean percentage of flowering adult plants was 26.7% ± 24.48 std. Demographic data can be found for all metapopulations in table 2, while figure 2 illustrates distribution of size classes for total population rather than on a metapopulation basis.

Mean slope angle was 30.13% ± 10.08 std, while canopy coverage averaged 87.71% ± 4.97 (Table 1). Ecological data is found in table 1.

Soil particle analysis, potassium levels, phosphorous levels, and pH are listed in table 3, while trends are shown for soil types (figure 3), phosphorous levels (figure 4), potassium levels (figure 5), and pH (figure 6).

All associated species are presented in table 4, while the most commonly occurring species are listed in table six.

An additional four populations were found or censussed after the completion of

the current project. These consisted of twelve more metapopulations. Only one population (22 ramets) was found at War Bluff Sanctuary, although 3 metapopulations (ramets 247,35, and 17) have been previously reported. A sighting at Bill Hill Hollow by Jody Shimp, while turkey hunting in Saline County, was verified. Two metapopulations were found (29 and 75+ ramets). A nearby population was also discovered by the author in Saline County at Buzzard Roost Hollow. This population was estimated at 250+ ramets. Seven metapopulations were newly discovered by the author on the banks of Burdon Creek (13, 25, 30, 15, 10, 100+).

Grindstaff Hollow was looked for, but the author could not find the population. A previous estimate puts this population at 3000+ ramets in 1992.

Recommended Status:

Illinois has been found to have the second largest number of populations for all states of occurrence. Due to the important nature of these populations for maintaining genetic diversity within the species, the author recommends the species remain as Threatened in order to assure future survival of Illinois populations and the species as a whole.

Literature cited:

Brown J. R. and D. Warncke. 1988. Recommended cation tests and measures of cation exchange capacity. in Recommended Chemical Soil Test Procedure for the North Central Region. Bulletin No. 499 (Revised) N. Dakota Ag Exp. Station, N. Dakota State University, pp. 15-16.

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

Drozda, N. 2000. Personal Communication with Terry Miller, Southern Illinois University: email.

Eckert, D.J. 1988. Recommended pH and lime requirement tests. in Recommended Chemical Soil Test Procedure for the North Central Region. Bulletin No. 499 (Revised) N. Dakota Ag Exp. Station, N. Dakota State University, pp. 6-7.

Kearney, T. H. 1897. New or otherwise interesting plants of Eastern Tennessee. Bull. Torr. Bot. Club 24: 560-575.

Knudson D. and D. Beegle. 1988. Recommended phosphorous tests. in Recommended Chemical Soil Test Procedure for the North Central Region. Bulletin No. 499 (Revised) N. Dakota Ag Exp. Station, N. Dakota State University, pp. 12-15.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South: Volume 1. USDA Forest Service, Technical Publication R8-TP2. pp. 397-400.

Ramsey G.W. 1965. A biosystematic study of the genus *Cimicifuga* (Ranunculaceae). Ph.D. dissertation, University of Tennessee.

_____. 1993c. Unpublished data. Ecological and phytogeographical information for *Cimicifuga rubifolia*. 3pp.

Lemmon, P.E. 1956. A spherical densiometer for estimating forest overstory density.

Forest Sci. 2:314-320.
Mohlenbrock, R.H. 1986. Guide to the vascular flora of Illinois. Southern Illinois University Press, Carbondale.
McCoy, R. 1999. Personal Communication with Terry Miller, Southern Ilinois University: email.
Ostlie, W.R. 1994. Element Stewardship Abstract for *Cimicifuga rubifolia*, Black cohosh. The Nature Conservancy. 17 pp.
Sabey, B.R. 1969. Introductory soil science. Stipes Publishing Company. Champaign, Il 61820. pp. 21-25.
Schwegman, J.E., G.D. Fell, M.D. Hutchison, G. Paulson, W.M. Shephard, and J. White. 1973. Comprehensive plan for the Illinois Nature Preserves System. Part II - The natural divisions of Illinois. Illinois Department of Conservation, Nature Preserves Commission, Springfield. 32 pp.

Table 1. Ecological data for sampled populations.* Aspect of 0 is due to having more than one metapopulation. Therefore, an average was not arrived at because of circular nature of compass measurement. In the instance of more than one matapopulation all other ecological values are an average for that site.

site name	aspect	slope %	soil depth	canopy cover %
Eddyville Bridge	347	31	12	93.24
Burke Branch	6	33	4	87.52
Manson Ford	122	30	12	82.32
Hayes Creek #1	278	44	12	89.6
Hayes Creek #2	86	32	12	81.28
Bell Smith Springs	0	32	12	89.11
Panther Hollow	68	23	12	86.48
Beartrack Hollow	34	34	12	88.56
Antioch Church	348	38	12	70.83
Owl Bluff	130	2	12	82.32
Cedar Lake	6	19	12	91.68
Millstone Bluff	85	28	12	89.6
Iron Furnace	351	50	12	91.68
Camp Cadiz	0	22	11	91.68
Thacker Hollow	0	31	12	89.9
Cane Creek	14	37	12	88.56
Blind Hollow	314	46	12	90.64
Rose Ford	80	30	12	86.48
Jackson Hollow Natural Area	96	27	5	88.56
Jackson Hollow Proposed Addition	0	21	12	87.05
Jackson Hollow Railroad	96	27	12	92.72

Table 2. Demographic data for all metapopulations.

Site Name	Plot #	Juveniles	Total Adults	% Flowering Adults
Panther Hollow	1	37	58	19.0
Cedar Lake	2	96	251	9.0
Jackson Hollow Natural Area	3	21	49	73.0
Jackson Hollow Railroad Site	4	3	5	80.0
Jackson Hollow Natural Area Proposed Addition 1	5a	16	13	62.0
Jackson Hollow Natural Area Proposed Addition 2	5b	2	15	27.0
Jackson Hollow Natural Area Proposed Addition 3	5c	11	197	2.0
Jackson Hollow Natural Area Proposed Addition Total	n=3	29	225	7.0
Rose Ford	6	0	215	28.0
Bell Smith 1	7a	188	27	0.0
Bell Smith 2	7b	13	12	8.0
Bell Smith Total	n=2	201	39	2.5
Burke Branch	8	69	109	3.0
Antioch Church	9	20	60	75.0
Blind Hollow	10	17	259	26.0
Cane Creek	11	26	47	6.0
Cadiz A	12a	6	56	46.0
Cadiz B	12b	3	64	52.0
Cadiz Total	n=2	9	120	49.0
Millstone Bluff 1	13a	9	208	26.0
Millstone Bluff 2	13b	0	39	7.0
Millstone Bluff 3	13c	1	39	28.0
Millstone Bluff Total	n=3	10	286	24.0
Manson Ford	14	119	145	40.0
Iron Furnace	15	10	333	46.0
Beartrack Hollow	16	620	415	23.0
Owl Bluff	17	9	2	0.0
Eddyville Bridge	18	3787	1071	16.0
Ferne Clyffe #1	19a	33	19	16.0
Ferne Clyffe #2	19b	47	166	33.0
Ferne Clyffe #3	19c	23	25	12.0
Ferne Clyffe #4	19d	126	394	18.0
Ferne Clyffe #5	19e	28	230	45.0
Ferne Clyffe #6	19f	18	166	7.8
Ferne Clyffe Total	n=6	275	1000	31.0
Haney Creek 1	20a	22	18	0.0
Haney Creek 2	20b	93	77	2.0
Haney Creek Total	n=2	115	95	2.0
Thacker Hollow 1	21a	14	111	7.0

Thacker Hollow 2	21b	10	75	7.0
Thacker Hollow 3	21c	88	582	11.0
Thacker Hollow 4	21d	187	2310	47.0
Thacker Hollow 5	21e	2	127	11.0
Thacker Hollow Total	n=5	301	3205	18.0

Table 3. Soils data for populations (including metapopulations). * indicates insufficient soil sample to perform particle analysis.

Site Name	pH	P(ppm)	K(ppm)	% sand	% silt	% clay	Soil name
Ferne Clyffe 1	6.1	7	119	68.8	10.4	20.8	Sandy Clay Loam
Ferne Clyffe 2	6.0	4	76.5	*	*	*	*
Ferne Clyffe 3	6.1	4	70.5	60.8	14.4	24.8	Sandy Clay Loam
Ferne Clyffe 4	7.0	7	141	74.8	20.8	4.4	Loamy Sand
Ferne Clyffe 5	6.7	5.5	165.5	*	*	*	*
Ferne Clyffe 6	6.8	5.5	92.5	73.6	11.2	15.2	Sandy Loam
Iron Furnace	7.0	4.5	121	*	*	*	*
Blind Hollow	7.2	3.5	90.5	81.6	13.2	5.2	Loamy Sand
Jackson Hollow Natural Area	5.3	6	117	57.6	12.8	29.6	Sandy Clay Loam
Jackson Hollow Railroad site	5.3	44.5	141	49.2	3.6	47.2	Sandy Clay
Jackson Hollow Natural Area Proposed 1	5.4	6	117	*	*	*	*
Jackson Hollow Natural Area Proposed 2	5.1	8.5	80.5	73.6	11.6	14.8	Sandy Loam
Jackson Hollow Natural Area Proposed 3	6.2	9	145	55.6	19.6	24.8	Sandy Clay Loam
Thacker Hollow 1	6.4	4.5	95	*	*	*	Loamy Sand
Thacker Hollow 2	6.8	10	157.5	59.6	7.6	32.8	Sandy Clay
Thacker Hollow 3	6.1	9	121	73.2	17.6	8.8	Sandy Loam
Thacker Hollow 4	6.5	8	139	73.6	15.2	11.2	Sandy Loam

Thacker Hollow 5	6.0	11.5	101	*	*	*	*
Haney Creek 1	6.5	12	159.5	*	*	*	*
Haney Creek 2	6.3	54.5	165.5	59.6	6.4	11.2	Sandy Clay
Cadiz A	5.8	21.5	113	65.6	17.2	17.2	Sandy Loam
Cadiz B	5.6	11.5	97	78.4	10.4	11.2	Sandy Loam
Antioch Church	7.0	14.5	117	*	*	*	*
Rose Ford	5.6	5	109	10.8	36.4	21.6	Clay
Cedar Lake	5.5	18.5	82.5	76.8	9.6	13.6	Sandy Loam
Eddyville Bridge	5.6	7	113	82.0	11.6	6.4	Loamy Sand
Cane Creek	6.0	11.5	64.5	63.6	12.4	24.0	Sandy Clay Loam
Beartrack Hollow	6.3	10	115	*	*	*	*
Owl Bluff	6.0	3	56.5	39.6	29.6	30.8	Clay Loam
Burke Branch	6.5	4.5	199.5	27.6	1.6	71.8	Clay
Manson Ford	6.3	7.5	199.5	80.0	19.2	0.8	Loamy Sand
Millstone Bluff 1	6.8	4	131	77.6	18.8	3.6	Loamy Sand
Millstone Bluff 2	6.4	4	177.5	65.2	8.8	26.0	Sandy Clay Loam
Millstone Bluff 3	5.9	9	143	71.6	4.8	23.6	Sandy Clay Loam
Bell Smith 1	6.1	4.5	109	28.8	3.6	67.6	Clay
Bell Smith 2	5.9	3	40.5	12.8	1.6	85.6	Clay
Panther Hollow	6.6	4	66.5	62.8	2.4	34.8	Sandy Clay

Table 4. List of associated plants in sampled populations.

Species Name	Common Name	Sites present
Staphylea trifolia L.	Bladdernut	1,2,3,4,5a,5c,6,8,10,11,12 a,12b,13a,15,16,19c,19d, 20b,21a,21b,21d,
Impatiens pallida Nutt.	Jewelweed	1,13c

Species Name	Common Name	Sites present
Acer saccharum Marsh.	sugar maple	1,2,3,4,5a,5b,5c,6,7a,7b,8 ,9,10,11,12a,12b,13a,13b, 13c,14,15,16,17,18,19a,1 9b,19c,19d,19e,19f,20a,2 0b,21a,21b,21c,21d,21e
Liriodendron tulipifera L.	tulip poplar	1,3,7a,9,10,11,13a,13c,14 ,17,16,18,19b,19d,21c,
Adiantum pedatum(Tourn.) L.	maidenhair fern	1,2,7a,7b,9,10,11,13a,16, 18,19c,19d,21a,21c,21e
Hydrophyllum canadense L.	Broad leaf waterleaf	1,4,7a,12a,13a,14,15,20b, 21c,21d,21e
Carya cordiformus(Wang) K.Koch	Bitternut Hickory	1,2,5b,5c,6,7a,8,9,10,11,1 2a,13a,13b,16,17,20a,20b ,20d,21a,21b,21c,21d,21e ,
Arisaema triphyllum (L.) Schott.	Jack -in-the- pulpit	1,2,3,4,7a,8,16,18,20a,
Polystichum acrostichoides (Michx.) Schott.	Christmas fern	1,2,3,45b,5c,6,7a,7b,8,9,1 0,11,12b,13a,13b,13c,15, 16,17,18,19c,19b,19e,19f, 21a,21b,21c,21e

Species Name	Common Name	Sites present
Asarum canadense L.	Wild ginger	1,2,3,4,5b,7a,8,9,10,11,12 a,13a,13c,14,15,16,18,19 a,19b,19c,19d,19e,19f,21 a,21c,21e,
Athyrium pycnocarpon (Spreng.) Tidestrom	Narrow leaved spleenwort	1,21d
Uvularia grandifolia Sm.	Yellow Bellwort	1,6,15
Prenanthes altissima L.	tall white lettuce	1,
Carex careyana Dewey	sedge	1,2,5a,5b,5c,12a,13a,13c, 15,19c,19d,19f,21a,21b,2 1c,21d,21e,
Solidago flexicaulis L	Broadleaf goldenrod	1,21d
Cacalia Muhlenbergii (Sch.-Bip.)Fern.	Great indian plantain	1,6,21c,21d
Sedum ternatum Michx.	three leaved stonecrop	1,10,

Species Name	Common Name	Sites present
Actaea pachypoda Ell.	Doll's eyes	2,3,5c,7a,10,12a,14,17,16 ,18,19a,19b,21b,21c,21d, 21e,
Polygonatum pubescens (Willd.)Pursh.	Small solomon's seal	2,3,20b,
Cystopteris protrusa (weatherby) Blasd.	Fragile fern	2,3,4,5a,5b,11,12b,13a,13 b,21a,21c,21d,
Dioscorea quaternata Walt. J.F. Gmel.	Wild yam	2,3,6,7a,8,9,10,11,12a,13 a,17,16,18,21a,21b,21c,2 1d,21e,
Fraxinus americana L.	White ash	2,6
Polygonum Virginianum L.	Virginia knotweed	2,3,11,12a,12b,15,19f,20b ,21a,21b,21c,21d,21e,
Galium triflorum Michx.	Sweet scented bedstraw	2,7a,12a,21a,
Botrychium virginianum (L.) Sw.	Rattkesnake fern	2,10,13a,15,19d,21d,

Species Name	Common Name	Sites present
Phlox divaricata L.	common flox	2,
Parthenocissus quinquefolia(L.) Planch.	Virginia Creeper	3,4,5b,5c,7a,7b,8,9,11,12a,12b,13b,14,15,16,18,19a,19b,19c,19d,19f,20a,20b,21e,
Phytolacca americana L.	Pokeweed	3,4,6,9,12a,20b
Sassafras albidum (Nutt.) Nees.	Sassafras	3,5b,5c,7b,17
Polymnia canadensis L.	Bear claw	3,4,6,10,11,15,18,21d,21e,
Impatiens pallida Nutt.	Jewelweed	3,7a,9,14,17,18,19c,
Juglans nigra L.	Black Walnut	3,5b,14,18,19a,19b,19c,21b,
Quercus rubra L.	Northern Red Oak	3,4,6,15,17,18

Species Name	Common Name	Sites present
Dryopteris marginalis (L.) Gray	marginal shield fern	3,5c,11,19a,19c,21b,21c,21d,
Caulophyllum Thalictroides (L.)Michx.	Blue cohosh	3,5b,11,
Menispermum canadense L.	Moonseed	3,6,8,12a,15,16,18,19c,19f,21c,21d,
Phyrma leptostachya L.	Lopseed	3,5b,8,9,14,15,16,21e,
Sanicula canadensis L.	Canadian black snakeroot	3,4,5a,5b,6,7a,8,10,11,12a,14,15,16,18,19c,19f,21b,21d,
Lindera benzoin (L.) Blume	Spicebush	3,4,5a,5b,6,7a,8,10,11,12a,12b,13a,13b,13c,14,15,17,16,18,19a,19b,19d,19e,19f,21a,21b,21c,21d,21e,
Hydrangea arborescens L.	Wild hydrangea	3,4,7b,11,12b,15,
Cornus florida L.	Flowering dogwood	3,6,10c,
Nyssa sylvatica Marsh.	Sour gum	3,

Species Name	Common Name	Sites present
Geum canadense Jacq.	White avens	3,5b,9,12a,14,15,19c,19d, 21d,21e,
Circeae Lutetiana (see Mohl.)	Enchanter's nightshade	3,4,19a,19b
Sanguinaria canadensis L.	bloodroot	4,7a,9,12a,16,18,19d
Asimina triloba (L.) Dunal.	paw paw	4,5a,5b,13a,13b,13c,15,16,18,19a,19b,19c,19d,19e,19f,20b,21a,21c,
Ulmus americana L.	American Elm	4,5c,13c,14,12a,18,19d,20a,21a,21c,21e,
Pilea pumila (L.) Gray	Clearweed	4,11,21a.21b,21c,21d,21e,
Campsis radicans (L.) Seem	Trumpet Creeper	4,21c,
Smilacina racemosa (L.) Desf.	False Solomon's seal	4,8,1213a,21d,21e,

Species Name	Common Name	Sites present
Hydrastis canadensis L	goldenseal	4,5a,5b,5c,7a,8,9,13a,16, 19f,21d,
Celtis occidentalis L.	Hackberry	6,13b,
Smilax hispida Muhl.	Bristly catbriar	6,13b,15,17,18,
Aesculus glabra Willd.	Ohio buckeye	6,14,18,
Ulmus rubra Muhl.	Slippery elm	6,7a,10,15,19f,21b,
Cryptotaenia canadensis (L.) DC.	Honewort	6,7b,14,16,21e
Phlox paniculata L.	Garden Phlox	6,
Panax quinquefolius L.	ginseng	5b,10,13a,21a,21c,19d,
Asplenium rhizophyllum L.	walking fern	6,
Urtica dioica L.	stinging nettle	6,10,14,15,18,21e,
Hackelia virginiana 9L.) I.M.	stickseed	6,

Species Name	Common Name	Sites present
Johnston.		
Eupatorium rugosum Houtt.	White snakeroot	6,13b,
Hybanthus concolor (T.F. Forst.) Spreng	Green violet	7a,8,9,10,11,12b,13a,14,15,16,18,19b,19d,20a,21a, 21b,21c,21d,21e,
Arundinaria gigantea (Walt.)Chapm.	Giant Cane	7b,12b,20a,
Toxicodendron radicans (L.) Kuntze	Poison Ivy	7b,9,10,12a,12b,14,15,16, 17,19b,19d,21a,21e,
Acer rubrum L.	Red Maple	8,
Podophyllum peltatum L.	Mayapple	8,12a,
Oxalis stricta L.	yellow wood sorrel	9,
Viola species undetermined	violet	10,12b,13b,16,
Smilax glauca Walt.	Catbriar	10,12a,21b,21c,21d,

Species Name	Common Name	Sites present
Campanula americana L.	American bellflower	10,11,12a,14,16,,19b
Phegopteris hexagonoptera (Michx.) Fee.	Broad beech fern	10,13a,16,20a
Quercus Muhlenbergii		5,10,11,19f,21b,21c,21d,
Solidago ceasia L.	Woodland goldenrod	11,
Boehmeria cylindrica (L.) Sw.	False nettle	11,17,18,19b,19c,19d,19e
Carex albursina Sheldon	carex	7b,11,15,21a,21d
Hepatica nobilis Mill. var acuta (Pursh) Steyerm.	Sharp lobed liverleaf	11,15,21a
Tradescantia subaspera Ker.	spiderwort	12a,13c,16,21d,
Carex laxiculmis Lam.	carex	12b,
Carex jamesii Schwein	carex	12b,

Species Name	Common Name	Sites present
Ostrya virginiana (Mill.) K.Koch.	hop hornbeam	12b,17,
Hydrophyllum virginianum L.	Virginia waterleaf	12b,
Carya ovata(Mill.)K.Koch	Shagbark Hickory	13a,16,21b,20b,
Polemonium reptans L.	Jacob's Ladder	13a,13c,14,15,16,18,
Viola sororia Willd.	wooly Blue violet	13a,14,
Ambrosia trifida L.	Giant Ragweed	14
Carpinus caroliniana Walt.	Musclewood	15,16,19b,19d
Festuca obtusa Biehler.	Nodding Fescue	17,
Liquidambar styraciflua L.	Sweet Gum	17
Senescio aureus L.	Golden ragwort	17

Species Name	Common Name	Sites present
Scutellaria ovata Hill.	Heart leaved skullcap	17,
Euonymous atropurpurea Jacq.Wahoo.		17
Stylophorum diphyllum (Michx.) Nutt.	Celandine Poppy	18,21a,20a,20b,
Osmorhiza longistylus (Torr.) D.C.	Anise root	17,
Celtis laevigata Willd.	sugarberry	18,20b,
Tradescentia ohioensis Raf.	Ohio Spiderwort	18,20a,21d,
Fagus grandifolia Ehrh.	Beech	19a,19c,20b,21a,21c,
Trillium grandiflorum (Michx.)Salisb	Large white trillium	21a,
Asplenium platynueron (L.) Oakes.	Ebony Spleenwort	21b,21e
Tilia americana L.	Basswood	21c,

Species Name	Common Name	Sites present
Viola pratincola Greene	Common Blue Violet	19b
Trillium flexipes Raf.	Large white trillium	19b
Platanus occidentalis L.	Sycamore	19d,19e,19f
Monardia bradburiana Beck.	Monarda	13c
Solidago caesia L.	Woodland goldenrod	5b,5c,21a
Galium circaezans Michx.	Wild licorice	5b
Phacelia bipinnatifida Michx.	Phacelia	12a,13b
Smilax bona-nox L.	Catbriar	7b
Cacalia atriplicifolia L.	Pale Indian Plantain	7b
Elymus virginicus L.	Virginia wild Rye	7b
Aristolochia serpentaria L.	Virginia Snakeroot	12a

Table 5. Status and number of populations in states of occurrence.

State	Status	Populations verified since 1970	Source
Tennessee	Threatened	56	McCoy, 1999
Illinois	Threatened	26	Compiled by author
Virginia	Not listed	7	Ostlie ,1994
Kentucky	Threatened	6	Drozda, 2000
Indiana	Endangered	1	Ostlie, 1994
Alabama	Endangered	1	Ostlie ,1994

Table 6. Most common associate species.

Species Name	Number of Occurrences
Acer saccharum Marsh.	37
Asarum canadense L.	29
Lindera benzoin (L.) Blume	29
Parthenocissus quinquefolia (L.) Planch	24
Carya cordiformus (Wang) K. Koch	22
Staphylea tripholia L.	21
Hybanthus concolor (T.F. Forst.) Spreng	19
Dioscorea quaternata Walt. J.F. Gmel.	18
Asimina triloba (L.) Dunal.	18
Sanicula canadensis L.	18
Actea pachypoda Ell.	16

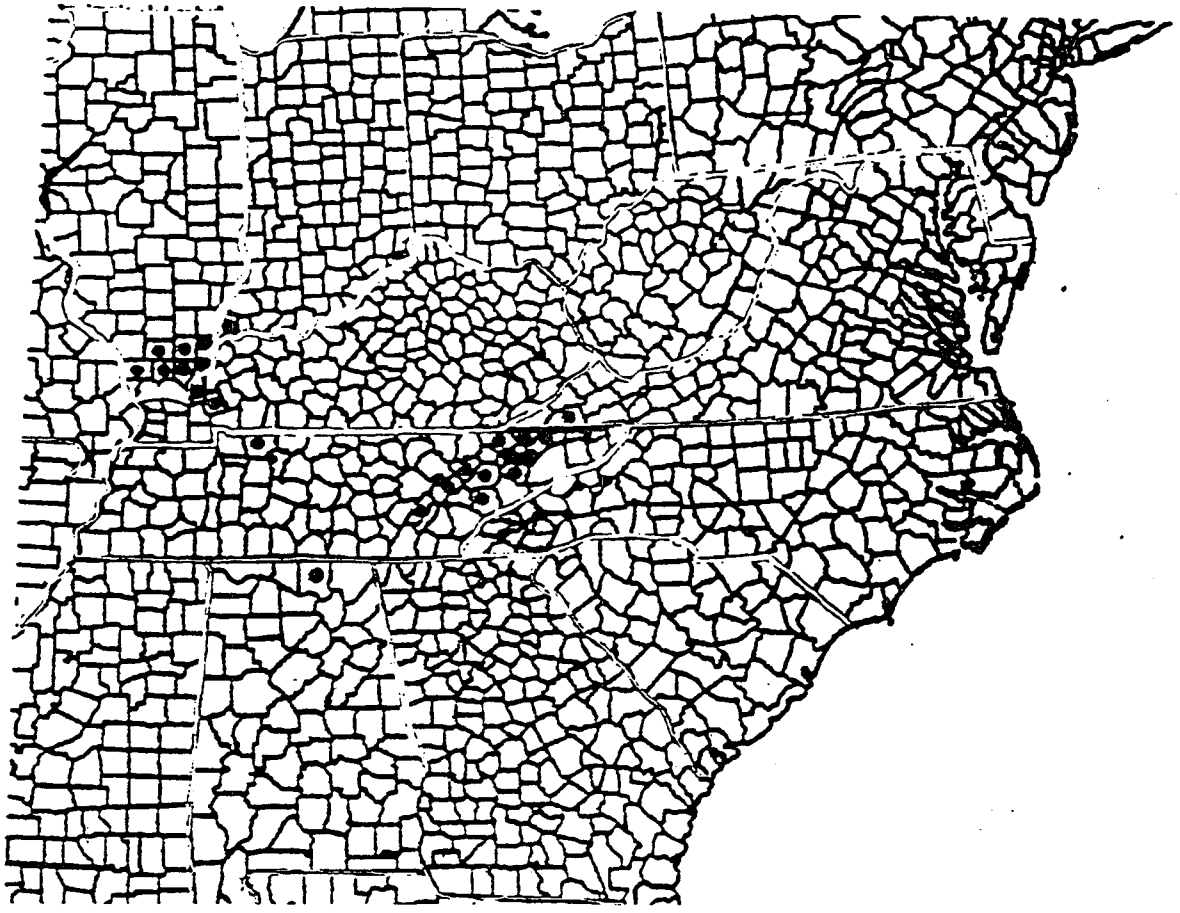

Figure 1 Populations by county for C. Rubifolia throughout specie's range.

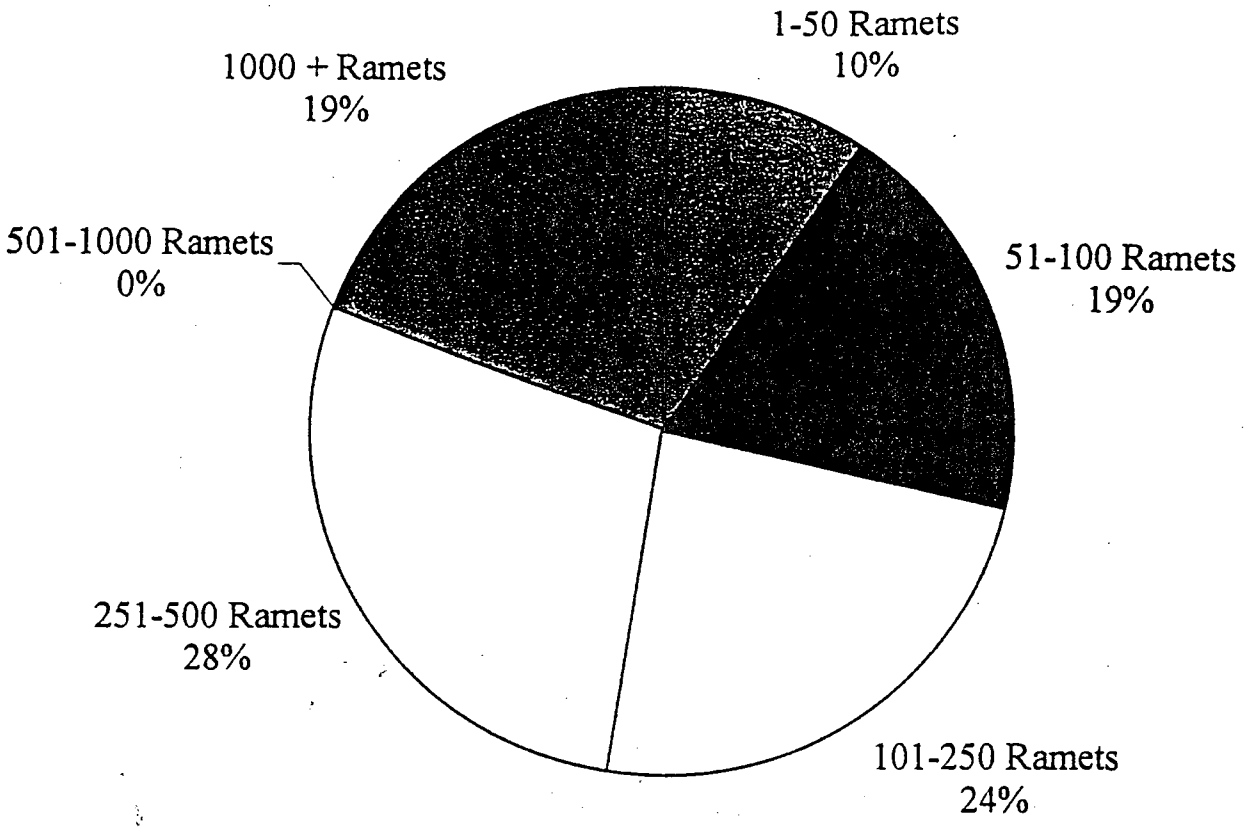

Figure 2 Distribution of size classes for total poulations.

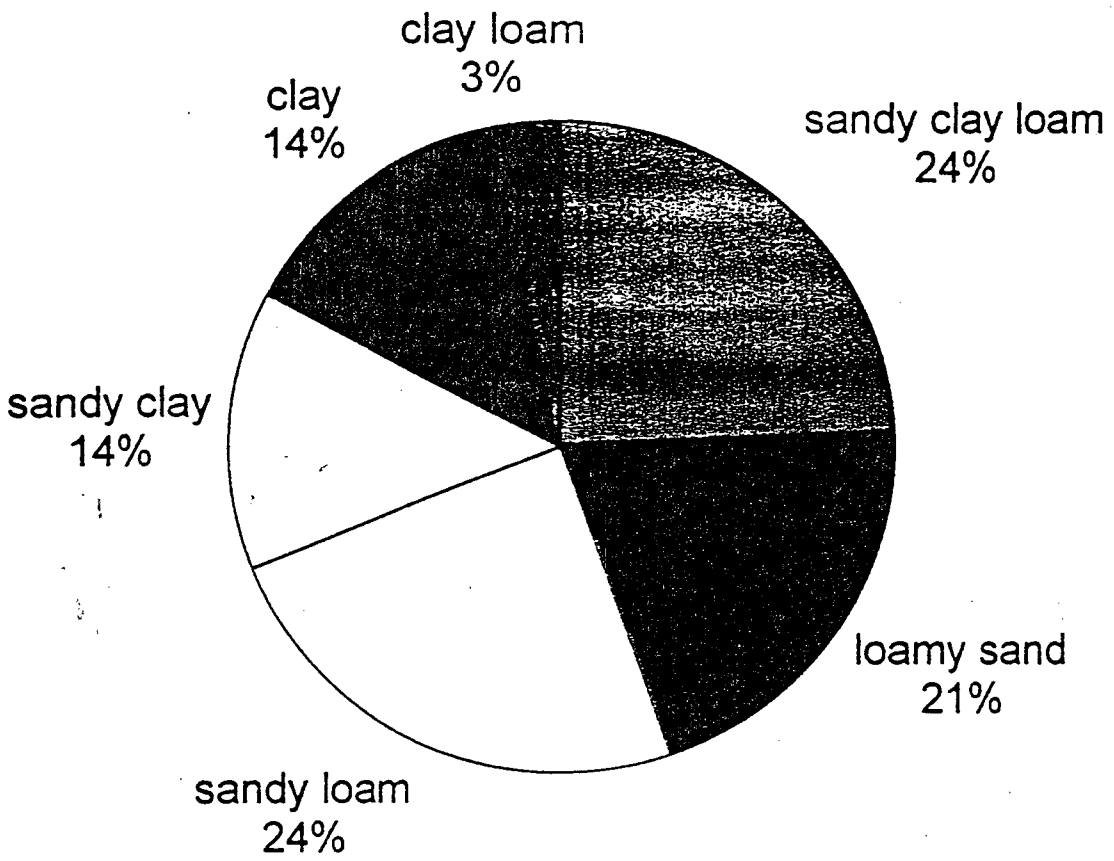

Figure 3 Soil types for metapopulations.

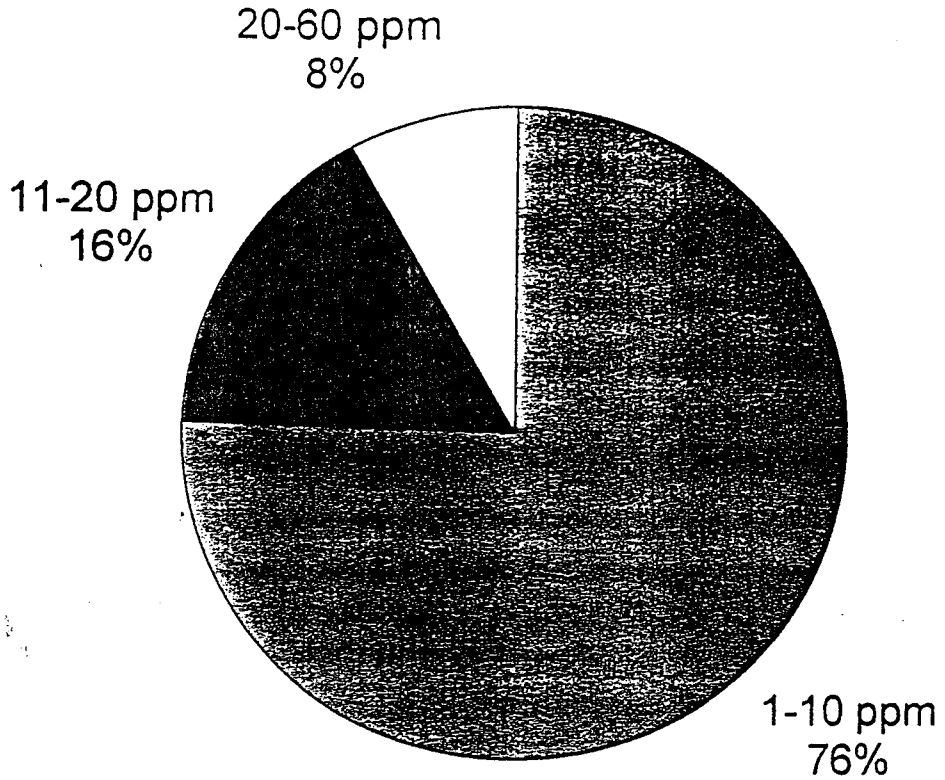

Figure 4. Phosphorus levels (ppm) for metapopulations.

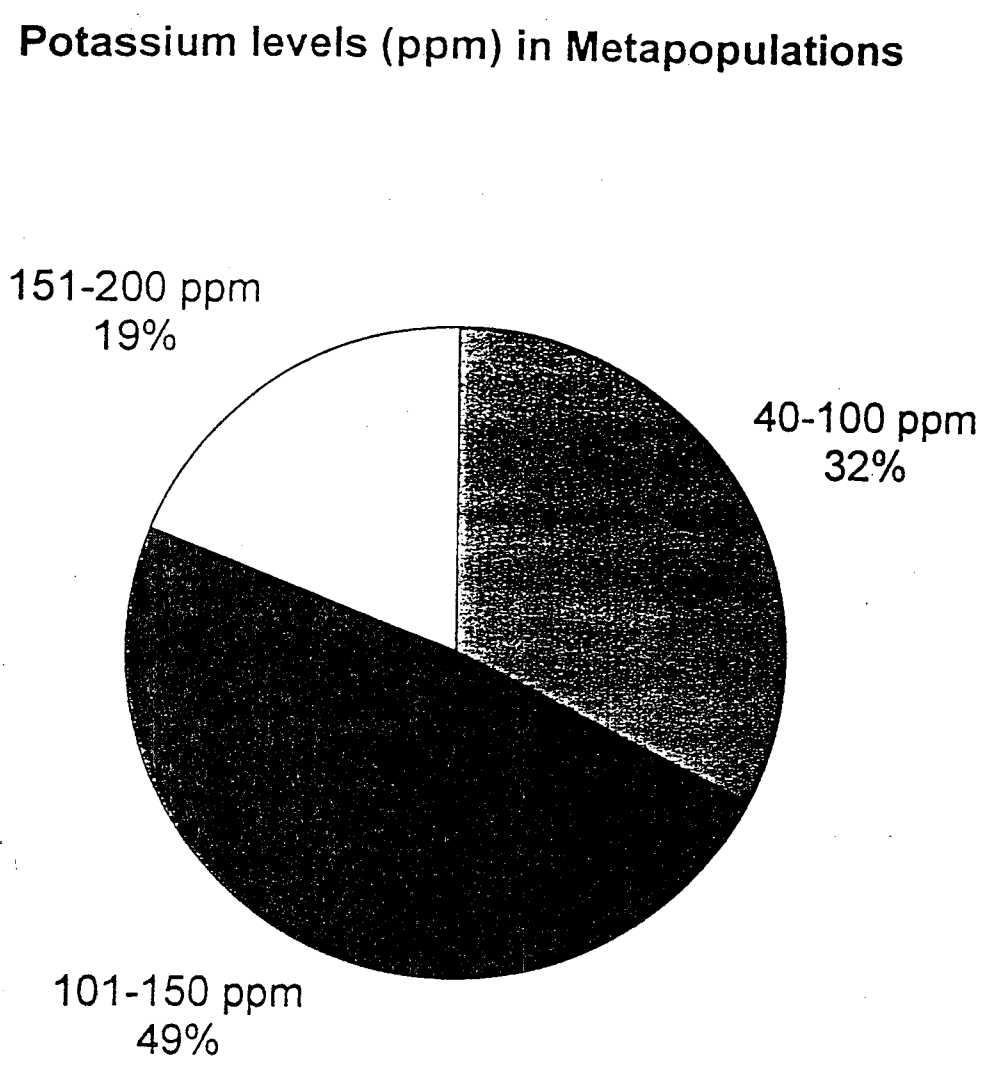

Figure 5. Potassium levels (ppm) for metapopulations.

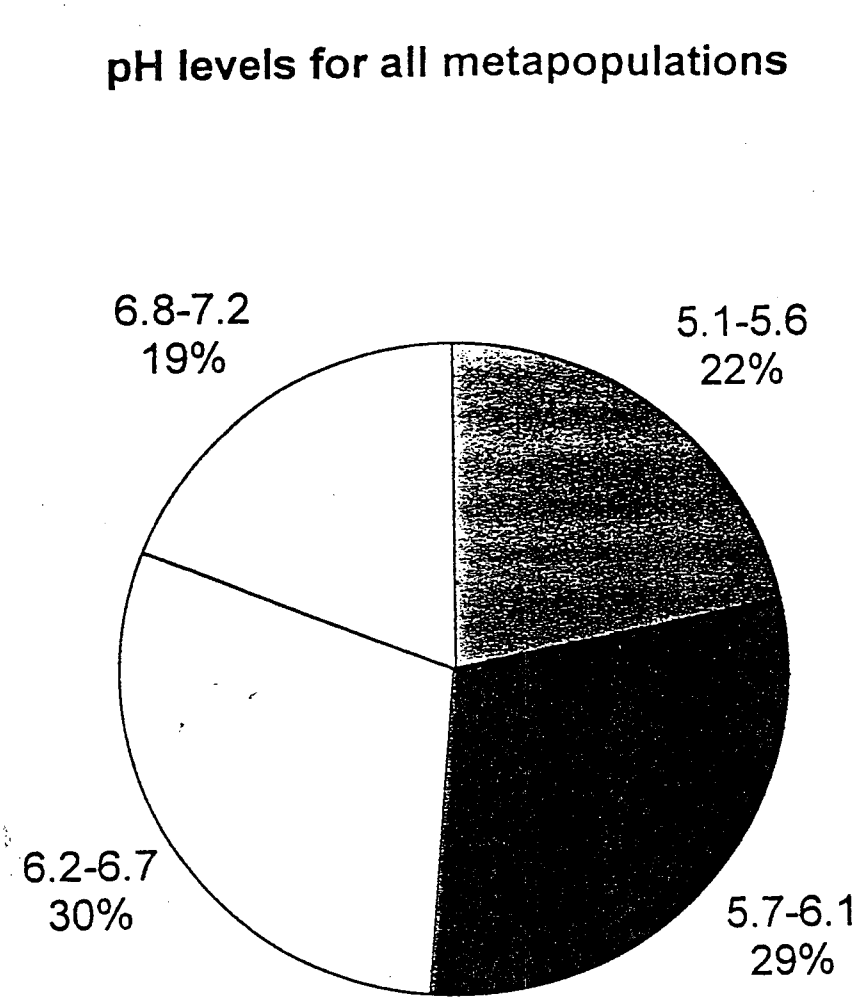

Figure 6. pH levels for all metapopulations.