On the Rare Endemic *Hydrophyllum brownei* Kral & Bates (Browne's Waterleaf): New Population Information and a Recommendation for Change in Status

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Abstract

Hydrophyllum brownei Kral & Bates (Browne's waterleaf), newly described in 1991, is endemic to the Ouachita Mountain Natural Division of Arkansas. For the purpose of better understanding population parameters within which *H. brownei* grows, ranges of shade values, population extents, and population distance relationships to streams were measured. *Hydrophyllum brownei* grows in extremely high shade, in populations of widely varying sizes, and always in association with a stream system. In order to list species associated with *H. brownei*, vouchers of species assemblages were collected at the *H. brownei* sites visited. The species is designated as critically imperiled globally because of its extreme rarity (G1). It is also extremely rare in Arkansas (S1) according to NatureServe and the Arkansas Natural Heritage Commission. Previously unknown populations were discovered in this study, and a recommendation to lower species rarity rank is made. However, based upon information gathered about population parameters, it is recommended that the species be reduced in status only to the global rank of G2 (imperiled globally because of rarity) and the state rank of S2 (very rare). *Hydrophyllum brownei* is currently known from 26 distinct sites, nine of which were discovered in 2002. Because *H. brownei* is a rare endemic to the Ouachita Mountains, continued intermittent monitoring of its populations is advised.

Introduction

Hydrophyllum brownei (Browne's waterleaf) is a recently described species endemic to the Ouachita Mountain Natural Division of Arkansas (Kral and Bates, 1991). It is characterized by deeply pinnately lobed leaves that often appear basal, a solitary, sometimes branched erect stem and peduncle, a dense multi-flowered cymose inflorescence that appears head-like, white to pale or bright lavender flowers, long-exerted stamens (Fig. 1), pubescence throughout, and a distinctive tuberous rootstock (Figs. 2, 3). Listed as a new discovery for Arkansas in 1951 (Moore, 1951), but known from a specimen made by George Engelmann in 1837 (Kral and Bates, 1991), early *H. brownei* collections were identified as *Hydrophyllum macrophyllum* Nutt. The distinctive tuberous rootstock, which is the most conspicuous feature that distinguishes *H. brownei* from the very similar *H. macrophyllum* and all other *Hydrophyllum* species, was not collected by early botanists (Figs. 2, 3). Bates collected the root material and recognized this and other differences enabling Kral and Bates (1991) to describe *H. brownei*. It is now thought that *H. macrophyllum* is restricted to a range east of the Mississippi River and that all collections from Arkansas are actually *H. brownei*. Because populations of the supposed *H. macrophyllum* were only of rare occurrence in Arkansas, *H. macrophyllum* was a species tracked by the Arkansas Natural Heritage Commission (ANHC). After the description of *H. brownei*, both species were tracked by the state. Now that all Arkansas specimens have been reviewed and annotated as *H. brownei*, and there is no record of *H. macrophyllum* in the state, ANHC removed *H. macrophyllum* from their tracking list in early 2003, allowing all the focus to be on *H. brownei* (Theo Witsell, personal communication). The species commands attention because it is not only rare in the state, but it is an Arkansas endemic, known only from the Ouachita Mountains and the Valley and Ridge (often lumped with the Ouachitas) Provinces.

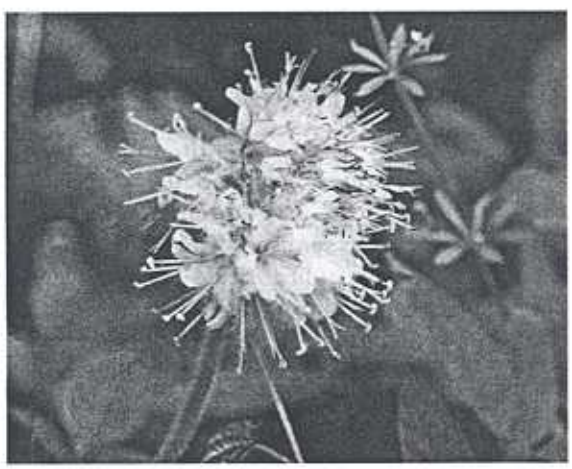

Fig. 1. *Hydrophyllum brownei* inflorescence. Note the long-exerted stamens.

Fig. 2. Entire *Hydrophyllum brownei* plant.

In North America, *Hydrophyllum* consists of nine species with both eastern and western assemblages, divided by the Great Plains. It is thought that the genus may have been more continuous in the past, but increasingly arid conditions in the mid-continent caused the separation into eastern and western assemblages (Beckmann, 1979). *Hydrophyllum brownei* falls into the eastern assemblage of species, but it is the only species in the eastern assemblage that is confined to an area west of the Mississippi River. All *Hydrophyllum* species, including *H. brownei*, are perennials except for *H. appendiculatum*, which is a biennial species (Beckmann, 1979).

Shade is an important factor for *Hydrophyllum* species (Beckmann, 1979), and no species completely departs from the characteristic mesophytic nature of the genus (Constance, 1942). FTN Associates (2001) noted that although the amount of shade is variable at *H. brownei* sites, all populations grew under dense riparian hardwood shade. Beckmann (1979) stated, "Rigorous habitat requirements for shade and moist, porous substrate coupled with unsophisticated seed dispersal restrict encroachment into new habitats." In other parts of the country where temperatures are not as high, there is more rainfall, and/or evaporation is not as significant, shade and moisture are not necessarily tied directly to streams, and *Hydrophyllum* species

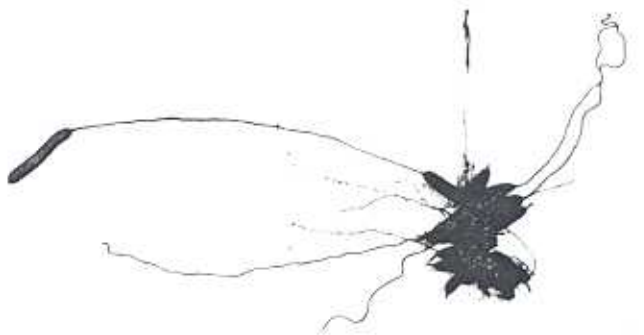

Fig. 3. Rootstock of a *Hydrophyllum brownei* plant. Note that the tubers produce fibrous roots apically, which may be again tuberous.

are not confined to stream-sides. In the Ouachita Mountains, however, the combination of shade and moisture is limited, severely restricting suitable habitat for *H. brownei*.

Since its description in 1991, little work has been done to understand the distribution and extent of *H. brownei*. The first work on the species after the initial publication was a survey conducted for ANHC (Hoang, 1999), followed by a status survey for the U. S. Fish and Wildlife Service (FTN Associates, 2001).

Hydrophyllum brownei has been designated as critically imperiled globally because of extreme rarity (G1) and designated as extremely rare in Arkansas (S1) by NatureServe and ANHC (Theo Witsell, personal communication). The basis for its classification is the number of distinct populations, viability of the populations, number of individuals in the populations, extent of the populations and geographical range, population trends, current and suspected future threats, inherent susceptibility to threats, and number of protected occurrences (Stein et al., 2000).

Materials and Methods

In this study most of the known sites were visited, and using information from previous work and field observations, a search was conducted for other populations. For a better understanding of how and where *Hydrophyllum brownei* populations are distributed and in what conditions the individuals are growing, certain population parameters were measured. From 13 May through 26 May 2002, most of the sites summarized by FTN Associates (2001) were revisited in order to determine the boundaries of the populations, count individuals, and take measurements on physical attributes of the sites. At each site, the bounds of the population were determined by pacing off the area and

Table 1. Location information for the 26 known *Hydrophyllum brownei* populations. Sites with an asterisk (*) were not visited in this study, and sites with a plus (+) were subdivided.

County	Brief site ID	7.5' Quad and TRS
Garland	Mazarn Creek	Pearcy Quad, T3S, R22W, Sec 25, center
*Howard	Cossatot River East of AR 4	Baker Springs Quad, T5S, R30W, Sec 26, NW 1/4
*Howard	Cossatot River North of AR 4	Baker Springs Quad, T5S, R30W, Sec 27, NE 1/4
Montgomery	Winding Stairs Trail, LMR	Athens Quad, T4S, R27W, Sec 32, NE 1/4
Montgomery	Buttermilk Springs Road and Collier Creek	Caddo Gap Quad, T3S, R24W, Sec 31, SE 1/4
Montgomery	Buttermilk Springs	Caddo Gap Quad, T4S, R24W, Sec 6, NW 1/4
Montgomery	North side of Caddo River in Black Springs	Norman Quad, T3S, R25W, Sec 30, center
Montgomery	Polk Creek Crossing on Pole Thicket Road	Norman Quad, T3S, R25W, Sec 31, NW 1/4
Montgomery	Southeast of chicken house on Rojo Lane	Norman Quad, T3S, R25W, Sec 31, SW 1/4
+Montgomery	Lick Creek NE of Gaston Road Bridge	Norman Quad, T3S, R26W, Sec 24, NW 1/4 and Sec 13, SW 1/4
Montgomery	Caddo Hills School	Norman Quad, T4S, R25W, Sec 12, NW 1/4
Montgomery	Mt. Gilead Church Road at Polk Creek Crossing	Norman Quad, T4S, R26W, Sec 1, NW 1/4 and Sec 2, NE 1/4
Montgomery	East of Opal on FR 5133	Pine Ridge Quad, T2S, R27W, Sec 30, SW 1/4
+Montgomery	Kates Creek	Pine Ridge Quad, T2S, R27W, Sec 32, NW 1/4
Montgomery	Caddo River on Mt. Gilead Church Road	Polk Creek Mtn. Quad, T3S, R26W, Sec 26, SW 1/4
Montgomery	AR 8 and Caddo River, near Jct. of FR 73	Polk Creek Mtn. Quad, T3S, R26W, Sec 28, SW 1/4
Montgomery	Caddo River Campsite	Polk Creek Mtn. Quad, T3S, R27W, Sec 25, SE 1/4
Montgomery	Polk Creek west of FR 73	Polk Creek Mtn. Quad, T4S, R26W, Sec 4, SW 1/4 and Sec 5, SE 1/4
*Pike	Little Missouri River	Athens Quad, T5S, R27W, Sec 17, NE 1/4
+Polk	Big Fork Natural Area	Big Fork Quad, T3S, R28W, Sec 10, SE 1/4
*Polk	Cossatot River at Gillham Springs	Eagle Mtn. Quad, T4S, R30W, Sec 15, SW 1/4 and Sec 22, NW 1/4
*Polk	Big Fork NW of Opal	Pine Ridge Quad, T2S, R28W, Sec 21, NW 1/4
Polk	Big Fork in Opal	Pine Ridge Quad, T2S, R28W, Sec 28, SE 1/4
Saline	Steel Bridge Road at Saline River	Lake Norrell Quad, T1S, R15W, Sec 8, NW 1/4
*Sevier	Cossatot River	Gillham Dam Quad, T7S, R30W, Sec 19, NW 1/4
*Yell	Petit Jean River	Blue Mtn. Dam Quad, T5N, R25W, Sec 15, NE 1/4

Table 2. Summary statistics of the measured population parameters for the 22 sites visited.

	Distance of individuals nearest stream (m)	Distance of individuals farthest from stream (m)	Minimum elevation above stream (m)	Population length (m)	Population width (m)	Population area (m2)	Percent canopy cover
Max	82	98	8.5	305	70	10120	99.480
Min	1	7	1	14	6	126	84.400
Median	4.5	30	2	64.5	15	666	96.925
Mode	3	15	1	100	9	270	98.960
Mean	11.727	34.095	2.045	89.182	23.095	2575.476	95.625
Standard Deviation	19.255	20.455	1.610	75.157	16.861	3322.827	4.493

Table 3. Most commonly collected taxa at *Hydrophyllum brownei* sites visited. Nomenclature follows PLANTS National Database.

Taxon Name	No. of Sites at Which Collected (22 Total)
Festuca subverticillata	17
Osmorhiza longistylis	14
Galium aparine	13
Viola pubescens	11
Elymus virginicus var. *virginicus*	10

using a Garmin E-Trex GPS. Because of the unforeseen state of senescence of individuals within the populations, counts of plants were not conducted. Population extent therefore was determined as the area within which individuals were found. Distance measurements also were taken of the individuals within populations that were observed growing closest to and farthest from their associated streams. In addition to linear distances, the individuals nearest the streams were measured for the minimum elevational distance above streams at which the populations grew. A concave spherical densiometer was used to determine the percent canopy cover of the populations. In addition to canopy cover, a list of canopy species was made at each site. Voucher specimens of associated vascular plant species were collected and later identified. Measurements made were summarized to determine the range, arithmetic mean, median, and mode of the population parameters.

Results

In addition to visiting known sites, seven previously unknown populations of *H. brownei* were located by the author, one by Theo Witsell, and one by Susan Hooks in 2002. There are now 26 distinct *H. brownei* sites known (Table 1). In this study, 19 of the 26 populations were visited. Three of the 19 sites visited were arbitrarily broken into paired sub-sites due to geographic features such as slopes, streams, or roads separating individuals within populations. The results presented are based upon visits to a total of 22 sites and sub-sites (Table 1).

Summary statistics are given for seven population parameters measured at the 22 sites visited (Table 2). In the majority of the populations visited, individuals closest to the stream channel were within 10 m of the stream (Fig. 4A). Although populations are restricted to true mesic and riparian habitat, depending on the size of the floodplain, individuals may grow a sizable distance from the stream

Table 4. Canopy cover species recorded from the 22 *Hydrophyllum brownei* sites visited. Nomenclature follows PLANTS National Database.

Taxon Name	No. of Sites Recorded	Taxon Name	No. of Sites Recorded
Liquidambar styraciflua	17	*Ilex opaca*	2
Platanus occidentalis	16	*Juniperus virginiana*	2
Ulmus spp.	13	*Lindera benzoin*	2
Acer negundo	9	*Acer saccharum*	1
Carya spp.	8	*Albizia julibrissin*	1
Celtis sp.	8	*Arundinaria gigantea*	1
Carpinus caroliniana	7	*Asimina triloba*	1
Fraxinus sp.	7	*Cercis canadensis*	1
Tilia americana	6	*Cornus florida*	1
Juglans nigra	4	*Cornus drummondii*	1
Magnolia tripetala	4	*Fagus grandifolia*	1
Ostrya virginiana	4	*Nyssa sylvatica*	1
Quercus falcata	4	*Prunus serotina*	1
Quercus rubra	4	*Quercus michauxii*	1
Robinia pseudoacacia	4	*Quercus nigra*	1
Pinus echinata	3	*Salix nigra*	1
Quercus alba	3	*Sideroxylon lanuginosum*	1
Gleditsia triacanthos	3	*Taxodium distichum*	1

channel (up to 100 m away). *Hydrophyllum brownei* grows in populations of varying sizes from just over 100 m^2 to over one hectare, but over half of the sites visited had population extents less than 1000 m^2 (Fig. 4B). None of the populations visited had individuals growing high above the stream channel (Table 2). High shade values (mean = 95.6%, sd = 4.49) appear to be required for the growth of individuals, as indicated from the sites visited (Fig. 4C).

Three hundred and forty-six voucher collections of species growing in association with *H. brownei* were made in May 2002. One hundred and thirteen unique taxa are represented by the collections and are listed alphabetically by family in the Appendix. The species associated with *H. brownei* at the sites visited are typical of shaded riparian or mesic areas. Table 3 shows the herbaceous species collected in the greatest number in May 2002. Although these species are common associates of *H. brownei*, interpretation of this list must be done with care. For example, *Toxicodendron radicans* (poison ivy) probably grows at nearly every site, but it is usually under-collected. Also, certain species that grow with *H. brownei* that were not reproductive at the time the sites were visited are underrepresented as well. Both Kral and Bates (1991) and FTN Associates (2001) list "typical" plants growing with *H. brownei*. The non-grass species that were most commonly collected in this study are also present in the handful of species listed by them. However, both commonly collected grass species (*Festuca subverticillata* and *Elymus virginicus* var. *virginicus*) were lacking from their lists (Table 3).

Only seven introduced taxa were collected from the sites (Appendix). It was surprising that so few introduced species were collected, as riparian areas are usually thought of as prime habitat for invaders. However, it must be noted that three of these *Lonicera japonica* (Japanese honeysuckle *Ligustrum sinense* (Chinese privet), and *Microstegium vimineum* (Nepalese browntop) are recognized as aggressive invasives. The Appendix supplies a list of all the taxa collected at *H. brownei* populations in May 2002, but it does not depict the abundance of any individual species at one site or any one species among the sites.

The canopy species recorded at the sites are typical of riparian and mesic habitats in the Ouachita Mountains (Table 4). The term canopy as used here refers to those species that shade *H. brownei* and includes those species typically referred to as sub-canopy species. The two most commonly cited species *Liquidambar styraciflua* (sweetgum) and *Platanus occidentalis* (American sycamore) typify riparian areas in the Ouachita Mountains. *Albizia julibrissin* (mimosa) was the only introduced "canopy" species recorded. *Arundinaria gigantea* (cane) was listed as a canopy species at one site because of the tremendous amount of shade it provided the *H. brownei* plants growing below it.

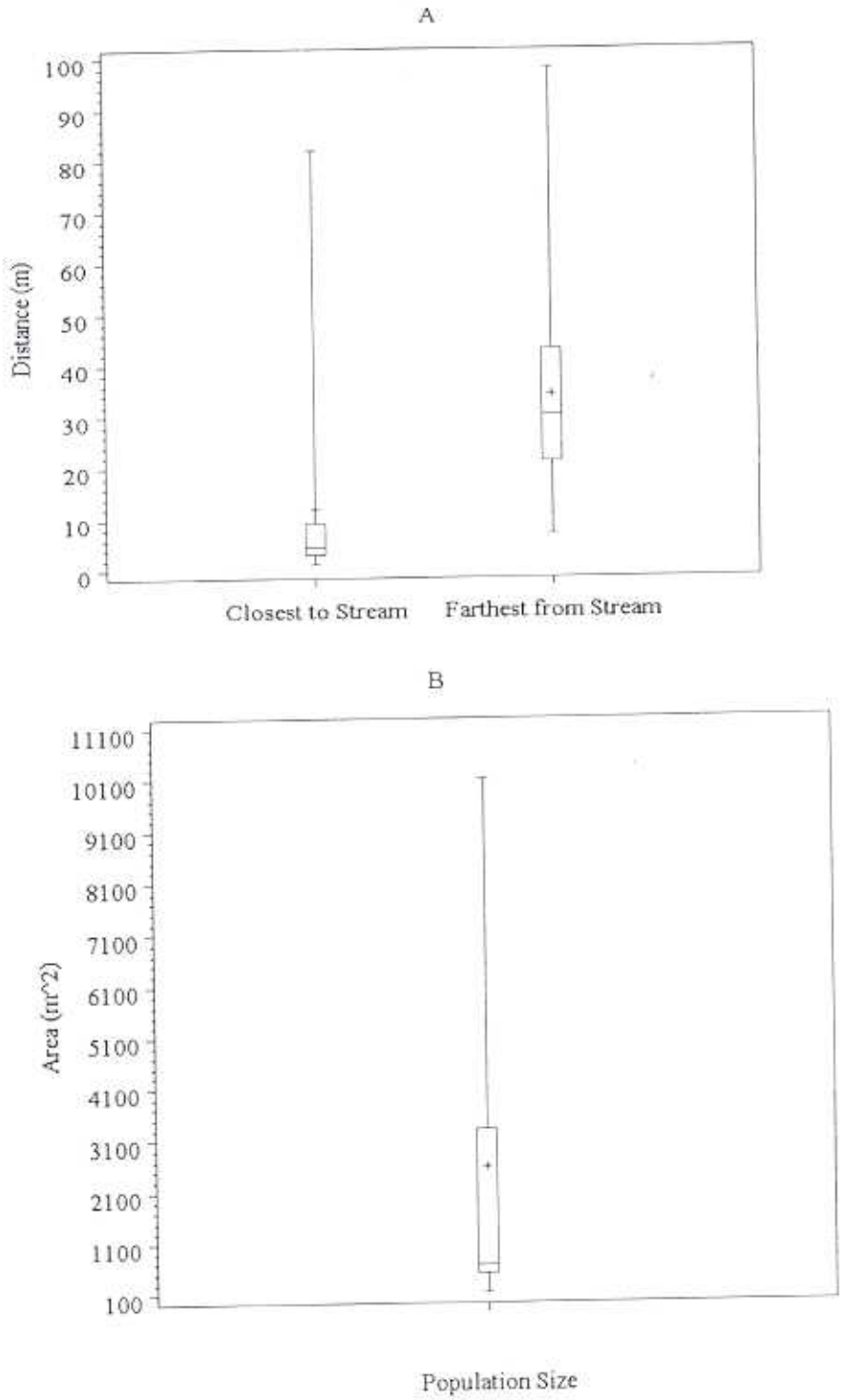

Fig. 4A. Box-plots for selected population parameters. From lowest to highest the box-plot displays the minimum value, the first quartile, the second quartile or median, the third quartile, and the maximum value observed. The + displays the arithmetic mean. (A) Summary of distances *H. brownei* plants grew from streams, (B) range of population areas.

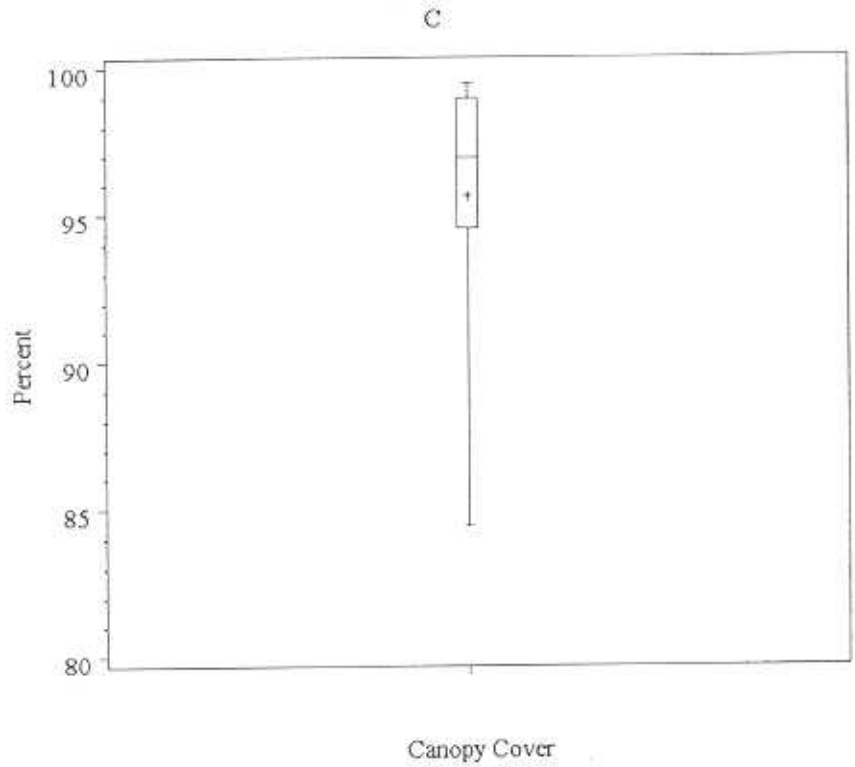

Fig. 4B. High levels of canopy cover were measured.

Discussion

The ranking system of NatureServe and the Natural Heritage network helps place parameters on determining rarity, but in addition to population sizes, extents, and species ranges, the viability of populations, threats, population trends, and protected sites must also be considered when determining levels of rarity (Stein et al., 2000). Rarity may be due to a species only occurring in a small or localized area, in rare or restricted habitats, or in overall low abundance over a broad area or range of habitat (Rabinowitz et al., 1986). There are no factors unique to rare plants. Rare plants simply are more restricted in range and/or number by the same processes that limit the distributions of more common plants (Gaston, 1994). The limited range of *H. brownei* could be due, at least in part, to a narrow tolerance range to physical factors in the environment. Likely candidates for the causes of *H. brownei*'s limited range are its requirements for high shade levels, its need for close proximity to water for seed dispersal (Beckmann, 1979), and its limited ability to compete with other species. In addition to its limited range of physiological tolerance, the habitat that *H. brownei* requires is limited in its region of growth. Although the Ouachita Mountains are dissected by drainages, suitable riparian/mesic habitat is not abundant. Often drier mixed pine forest is found directly at a stream or drainage bank in the region. Finally, *Hydrophyllum brownei* is endemic to the Ouachita Mountains. Although endemism and rarity are not synonymous (Gaston, 1994), as an endemic, *H. brownei* is further restricted in its distribution.

Currently, *H. brownei* is an Arkansas inventory element with a G1S1 ranking–critically imperiled globally because of extreme rarity and extremely rare in Arkansas. After recent work resulted in the confirmation of known populations (FTN Associates, 2001) and discovery of previously unknown sites, the species may be better represented by a reduction in status to the global rank of G2 (imperiled globally because of rarity) and the state rank of S2 (very rare). *Hydrophyllum brownei* is now known from 26 distinct sites. Based upon number of occurrences alone, the species would now fall into the categories of G3 (found

Fig. 5. Arkansas counties showing distribution of known *Hydrophyllum brownei* populations. Numbers in parentheses represent the number of known populations for the counties.

locally in a restricted range, usually with 21 to 100 sites known) and S3 (rare to uncommon, between 20 and 100 sites). However, considerations other than number of occurrences must be taken into account.

As an endemic to the Ouachita Mountains of Arkansas, the species requires an extra level of attention. *Hydrophyllum brownei* has a very small range, and 22 of the 26 known populations grow within a radius of 30 km. The species is known from eight counties in Arkansas, but over two-thirds of the known populations are from Montgomery and Polk counties alone (Fig. 5). It was also found that within its small range, *H. brownei* was greatly restricted to areas no more than 100 m from stream courses. Although no immediate pressures from development are threatening the species, the majority of the populations (at least 16) are located on private land holdings. In addition, not all populations are equally vigorous, and although some populations number in the thousands of individuals, others have been found with fewer than 20 (FTN Associates, 2001; Marsico, unpublished). It was determined that populations vary widely in extent but that the majority of them are small. Small population extent must be considered when assessing rarity status. Climate change in the area or even a small scale catastrophe could have a serious impact on the entire species due to its very limited range. Still, the G1S1 ranking is clearly no longer appropriate. It is recommended that the species status be reduced only to the less critical G2S2 ranking based on the small range and inconsistent vigor of the populations.

Continued monitoring and searches to find further *H. brownei* populations are also recommended. However, the prime time for searching discussed by both Kral and Bates

(1991) and FTN Associates (2001), May, is too late for accurate individual plant counts. Flowering individuals remain observable above ground for a much longer time than non-flowering individuals. As long as an investigator is familiar with the species, populations can be found from mid-March through May. Therefore, counts of individuals for monitoring purposes should be conducted early in the season from mid-April to early May. It may be that ratios of flowering individuals to non-flowering individuals will prove difficult to determine, as those plants that do not flower in a given year senesce much earlier than those that do flower. In addition, it is a possibility that certain individuals are dormant through an entire growing season, remaining underground as a viable rootstock, as in certain members of Asclepiadaceae (Alexander et al., 1997) and some other herbaceous perennials. Future searches may result in recommendations for further lowering of rarity ranking if populations continue to be located. At the present time, however, G2S2 is the most appropriate ranking for *H. brownei*. Additional investigations and studies of natural history, ecology, distribution patterns, and conservation genetics are warranted to better understand this rare Arkansas endemic.

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Appendix–List of vascular plant taxa collected from *Hydrophyllum brownei* populations, May 2002. Nomenclature follows PLANTS National Database.

Origin	Family	Species
N	Acanthaceae	*Ruellia strepens*
N	Aceraceae	*Acer negundo*
N	Anacardiaceae	*Toxicodendron radicans*
N	Annonaceae	*Asimina triloba*
N	Apiaceae	*Chaerophyllum procumbens* var. *procumbens*
N		*Cryptotaenia canadensis*
N		*Osmorhiza longistylis*
N		*Sanicula canadensis*
N		*Sanicula odorata*
N	Aquifoliaceae	*Ilex decidua*
N		*Ilex opaca*
N	Araceae	*Arisaema dracontium*
N		*Arisaema triphyllum*
N	Aristolochiaceae	*Asarum canadense*
N	Aspleniaceae	*Asplenium platyneuron*
N	Asteraceae	*Heliopsis helianthoides*
N		*Krigia dandelion*
N		*Packera obovata*
N	Berberidaceae	*Podophyllum peltatum*
N	Betulaceae	*Carpinus caroliniana*
N	Boraginaceae	*Cynoglossum virginianum*
N		*Myosotis verna*
N	Brassicaceae	*Arabis laevigata* var. *laevigata*
I	Caprifoliaceae	*Lonicera japonica*
N		*Symphoricarpos orbiculatus*
I	Caryophyllaceae	*Stellaria media*
N	Celastraceae	*Euonymus americana*
N	Commelinaceae	*Tradescantia ernestiana*
N		*Tradescantia ohiensis*
N	Cornaceae	*Cornus drummondii*
N		*Cornus florida*
N	Crassulaceae	*Sedum ternatum*
N	Cyperaceae	*Carex amphibola*
N		*Carex blanda*
N		*Carex jamesii*
N		*Carex oligocarpa*
N		*Carex oxylepis* var. *oxylepis*
N		*Carex retroflexa*
N		*Carex rosea*
N		*Carex texensis*
N	Dryopteridaceae	*Cystopteris protrusa*
N		*Onoclea sensibilis*
N		*Polystichum acrostichoides*
N	Ebenaceae	*Diospyros virginiana*
N	Fabaceae	*Cercis canadensis* var. *canadensis*
N		*Robinia pseudoacacia*
N	Fagaceae	*Quercus falcata*
N		*Quercus michauxii*
N		*Quercus shumardii* var. *shumardii*
N	Fumariaceae	*Corydalis flavula*
N	Gentianaceae	*Frasera caroliniensis*
N	Geraniaceae	*Geranium maculatum*
N	Hamamelidaceae	*Hamamelis vernalis*
N		*Liquidambar styraciflua*
N	Hippocastanaceae	*Aesculus glabra*
N	Hydrophyllaceae	*Hydrophyllum brownei*
N		*Nemophila phacelioides*
N		*Phacelia hirsuta*
N	Iridaceae	*Iris cristata*
N	Lamiaceae	*Monarda russeliana*
N		*Prunella vulgaris* ssp. *lanceolata*
N		*Scutellaria elliptica* var. *elliptica*
N	Lauraceae	*Lindera benzoin*
N		*Sassafras albidum*
N	Liliaceae	*Allium canadense* var. *canadense*
N		*Polygonatum biflorum*
N		*Trillium viridescens*
N	Loganiaceae	*Spigelia marilandica*
N	Magnoliaceae	*Magnolia tripetala*
N	Menispermaceae	*Calycocarpum lyonii*
N		*Cocculus carolinus*
I	Oleaceae	*Ligustrum sinense*
N	Ophioglossaceae	*Botrychium virginianum*
N	Papaveraceae	*Sanguinaria canadensis*
N	Platanaceae	*Platanus occidentalis*
N	Poaceae	*Arundinaria gigantea*
N		*Bromus pubescens*
N		*Diarrhena obovata*
N		*Dichanthelium boscii*
N		*Dichanthelium commutatum*
N		*Elymus virginicus* var. *virginicus*
N		*Festuca subverticillata*
N		*Melica mutica*
I		*Microstegium vimineum*
N		*Poa sylvestris*
N	Polemoniaceae	*Phlox divaricata* ssp. *laphamii*
N		*Polemonium reptans*
I	Polygonaceae	*Rumex obtusifolius*
N	Ranunculaceae	*Ranunculus recurvatus*
N		*Thalictrum revolutum*
N	Rhamnaceae	*Berchemia scandens*
N		*Frangula caroliniana*
I	Rosaceae	*Duchesnea indica*

Origin	Family	Species
N		*Geum canadense*
I		*Potentilla recta*
N	Rubiaceae	*Galium aparine*
N		*Galium circaezans*
N		*Galium triflorum*
N	Sapotaceae	*Sideroxylon lanuginosum*
N	Smilacaceae	*Smilax glauca*
N		*Smilax rotundifolia*
N	Staphyleaceae	*Staphylea trifolia*
N	Tiliaceae	*Tilia americana* var. *caroliniana*
N	Ulmaceae	*Ulmus alata*
N		*Ulmus americana*
N		*Ulmus rubra*
N	Violaceae	*Viola affinis*
N		*Viola pubescens*
N		*Viola sororia*
N		*Viola striata*
N	Vitaceae	*Parthenocissus quinquefolia*
N		*Vitis cinerea* var. *cinerea*
N		*Vitis vulpina*

I = Introduced N = Native