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Stanley E. Trauth
Arkansas State University

J. D. Wilhide
Arkansas State University

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Status of Three Plethodontid Salamanders (Genus *Plethodon*) from the Ouachita National Forest of Southwestern Arkansas

Stanley E. Trauth and J. D. Wilhite
Department of Biological Sciences
Arkansas State University
State University, AR 72467

Abstract

A three-year field investigation was initiated in 1996 to update previous information on the local abundance and distribution of three salamanders of the genus *Plethodon* (*P. caddoensis*, *P. fourchensis*, and *P. ouachitae*); these salamanders are found within a five-county area of the Ouachita National Forest in southwestern Arkansas. *Plethodon fourchensis* was most numerous at three sites in Polk County; a total of 18 specimens was found. Searching for *Plethodon fourchensis* was successful following moderate-to-heavy precipitation but only in selected habitats on Fourche and Irons Forks mountains. The preferred habitats of *P. caddoensis* were talus-covered slopes and wet ravines consisting of mostly small loose rocks within the Caddo Mountains. This species was found at 17 of 25 collection sites ($n = 108$); the largest single collection ($n = 52$) occurred on 19 April 1998. Rocky habitats with an abundance of leaf litter on Rich Mountain yielded *Plethodon ouachitae* in modest numbers ($n = 45$); three new locality sites were found during this study. Although new localities were discovered for each species during this study, none occurred outside its currently recognized range. Current forest management/landscape practices should strive to prevent any precipitous declines in populations of these salamanders.

Introduction

Historical Perspective and Review.—Traditionally, herpetological field survey data gained from local, regional, and state inventories have yielded a wealth of specific locality information about the presence (or absence) of a herpetofaunal species in a geographic area and have provided an important resource to supplement our knowledge and understanding of the distribution and ecological requirements of a particular species. Fortunately, a considerable amount of historic locality information is available from museum collections throughout the United States. These repositories of specimens and data contain priceless holdings of organisms and, thus, provide scientists with a database from which to assess the current trends and effects of habitat perturbations on a species' distribution and/or its local abundance. Yet, only by analyzing marked habitat change across the intervals of both time and space, can researchers reveal any significant changes in population size and structure in a species. This is especially true for North American terrestrial salamanders. Today, man's alterations to forest quality (by means of deforestation, habitat fragmentation, timber harvesting, etc.) have caused a rapid decline in total environmental quality; for instance, terrestrial salamanders within the Appalachian Mountains are known to have been dramatically impacted by forestry practices which have resulted in a loss of microhabitat diversity and have caused a reduced abundance within localized populations (Dodd, 1997). Plethodontid salamanders, in particular, are vulnerable to clearcutting and are less abundant in

young timber stands where clearcutting has occurred (e.g., Petranka, 1994; Petranka et al., 1993, 1994). Consequently, the declines in salamander numbers observed within populations in the eastern United States (due to habitat degradation) may well represent a harbinger of what can happen to similar plethodontid species elsewhere.

Three species of plethodontid salamanders (Fourche Mountain salamander, *P. fourchensis*; Rich Mountain salamander, *P. ouachitae*; Caddo Mountain salamander, *P. caddoensis*) are found within the Ouachita National Forest of southwestern Arkansas. They have shared a long history of scientific scrutiny ever since the description and naming of the first of these recognized species, *P. ouachitae* (Dunn and Heinze, 1933), over 65 years ago. In recent years, their habitat requirements have become a topic of special concern to forest managers (see Sievert, 1986). Because these three *Plethodon* species have limited distributions and appear to have unique habitat preferences, they have been given special collection protection by the U. S. Forest Service and are generally considered as "species at risk." Current silvicultural practices in the Ouachita National Forest no longer utilize clearcutting as a permissible timber management practice, and streamside protection zones have been established for these *Plethodon* as well as for other plethodontid salamanders in the Ouachitas. Furthermore, mining activities have been prohibited or largely curtailed within most of the known ranges of these three salamanders.

Literature reviews dealing with the biology of *P. caddoensis*, *P. ouachitae*, and *P. fourchensis* were published by Pope (1964), Blair (1967), and Highton (1986), respectively.

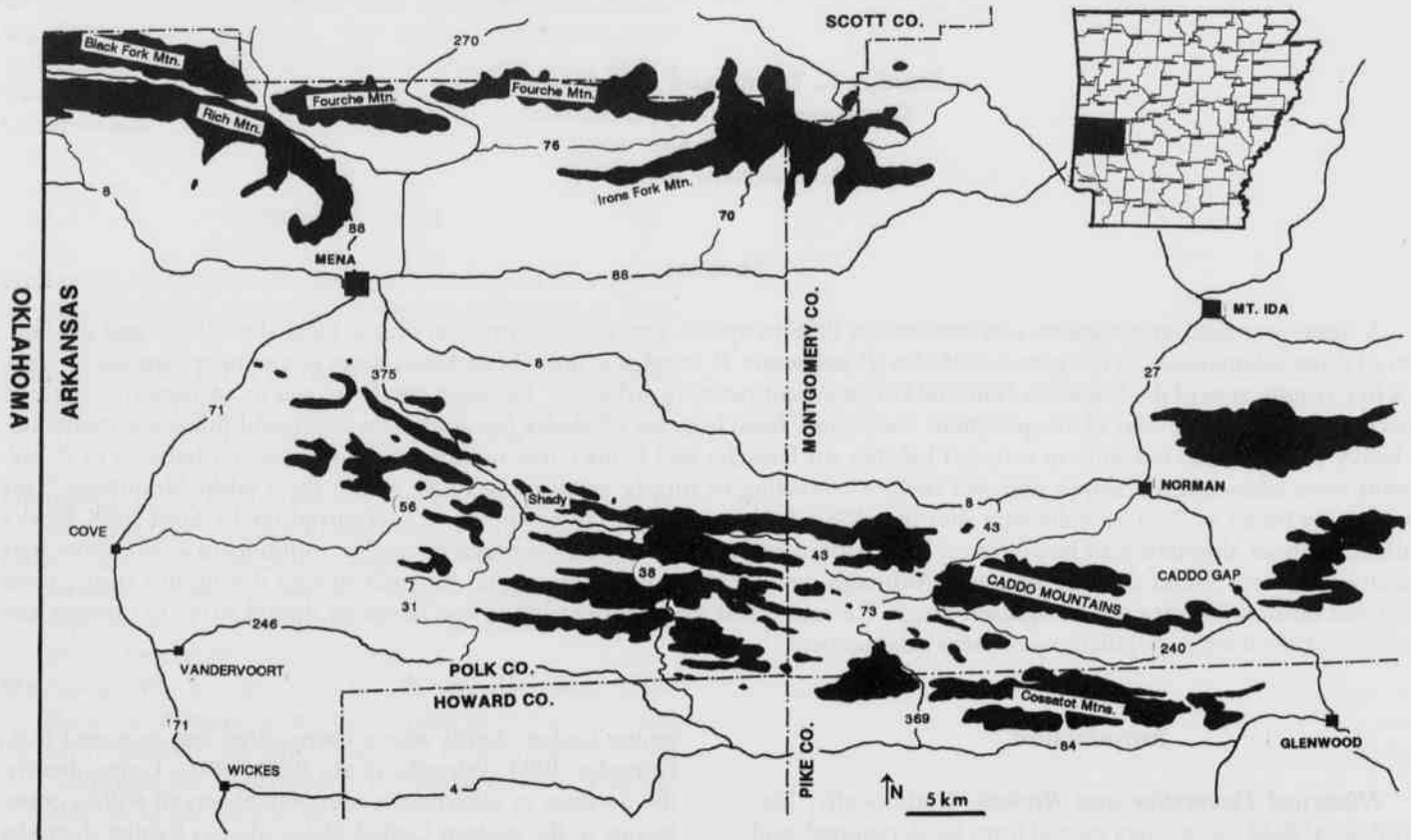


Fig. 1. Map illustrating the study area within a five-county region of southwestern Arkansas. The elevated mountainous habitats of the Ouachita National Forest are shown in black (> 440 m = Fourche Mountain, Rich Mountain, and western Caddo Mountains of Polk County; 300 - 440 m = eastern Caddo Mountains region of Montgomery and Pike counties). Numerals indicate selected highways and National Forest roads.

Additional information on these species can be found in works by Kuss (1986) and Sievert (1986). Winter et al. (1986) reported on parasitism in these species, whereas Atwill and Trauth (1988) published on mandibular dentition. Taylor et al. (1990) investigated the reproductive biology. Anthony et al. (1997) reviewed recent studies on social behavior and aggression in *Plethodon* (includes works on *P. caddoensis* and *P. ouachitae*).

The current field investigation began in 1995 to supply new information on local distribution and abundance of two of the three *Plethodon* salamanders (*P. fourchensis* and *P. caddoensis*); survey on the third species, *P. ouachitae*, was initiated in 1997. The above field work was authorized through two Challenge Cost-Share Agreements between the U. S. Forest Service and Arkansas State University. These projects were designed to gain new knowledge on the current distribution, range, ecological associates, habitat requirements and preferences, and life history of these species. New locality data would specifically augment information generated by several previous studies and surveys. This project was also under-

taken to seek information on any trends in salamander numbers as revealed through the examination of historic collection records currently deposited in the Arkansas State University herpetological collection. Therefore, this study includes a combination of many historic locality records along with the recent locality data (1996-1998) generated by the current investigation. We have attempted to provide these combined records to show some continuity between the various field surveys on these salamanders.

Methods

Sampling Activity and Techniques.—Over an 18 yr span (1980-1998), one of us (SET) has conducted numerous herpetofaunal field trips to a five-county area of the Ouachita Mountains of southwestern Arkansas (Fig. 1); during each visit, a considerable amount of time and effort was devoted to searching for all species of plethodontid salamanders within this area. On many occasions, the senior author was

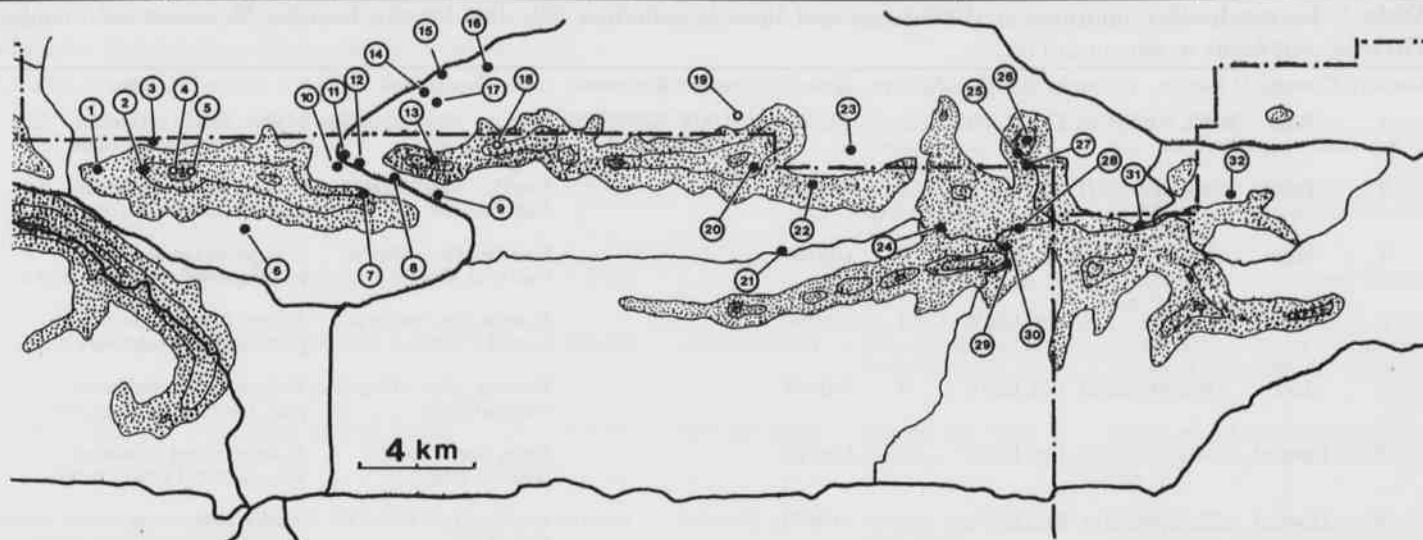


Fig. 2. Map illustrating historic collection sites and/or localities visited during the recent study of *Plethodon fourchensis* in the Fourche Mountain area. Outermost contour lines approximate 440 m in elevation; inner contour lines show increases in elevation at increments of ca. 150 m. See Table 1 for explanation of numbered sites.

assisted by student help in collecting salamanders; normally 5-10 students attended annual field trips conducted during the month of April. In addition, both of us have periodically but routinely visited specific sites to obtain seasonal samples of salamanders.

Selected habitats were searched for salamanders by turning surface rocks and logs or excavating loose talus by hand or potato rakes. In particularly wet areas, such as along or within creekbeds, mountain seeps and ravines, an intensive turning of accumulated leaf litter was often performed. During especially dry conditions and/or during hot weather, more effort was expended on breaking up logs to search for salamanders. Voucher specimens were taken from most sampling sites and are currently catalogued and housed in the Arkansas State University herpetological collection. All collections were conducted during daylight hours.

Although the recent survey work (1996-1998) focused primarily on visiting some of the numerous historic collection sites for the three species, we also attempted to discover additional localities. Information pertaining to the historic localities was gleaned from the scientific literature on the species (e.g., Pope and Pope, 1951; Blair and Lindsay, 1965; Duncan and Highton, 1979; Heath et al., 1986), from an unpublished survey conducted for the Arkansas Natural Heritage Commission (on *P. fourchensis* and *P. caddoensis* reported by Plummer, 1982), and from unpublished field data of the U. S. Fish and Wildlife Service (previously used to prepare status reviews on *P. fourchensis* and *P. caddoensis* as written by Linda LaClaire-USFWS office, Jackson, MS). We utilized locality information on abandoned mines as well as considerable field assistance from David Saugey (U. S. Forest Service, Ouachita National Forest-Jessieville office).

Results and Discussion

***Plethodon fourchensis*.**—The Fourche Mountain salamander is one of the two endemic Arkansas plethodontid salamanders examined in this report; it is known only from parts of Fourche and Irons Fork mountains in Polk and Scott counties (Highton, 1986). All but three of the 32 designated survey sites illustrated for *P. fourchensis* in Fig. 2 were surveyed during the recent field work; the locality information on these sites is found in Table 1. The most productive sites for collecting the Fourche Mountain salamander were site 10, 11, and 12 within a 2 km area W of Foran Gap and along either side of U. S. Hwy 71. Riparian habitat along the headwater region of Cedar Creek is found to the N of the highway, whereas a series of mountain ravines which drain into Cedar Creek are found to the south. We have repeatedly secured *P. fourchensis* in the vicinity of these designated sites on numerous visits with sampling following moderate-to-heavy precipitation being notably productive. Wet conditions are especially crucial to the successful collection of *P. fourchensis*. The largest single collection ($n = 17$) was on 7 May 1994 during a visit to site 12 with the Nature Conservancy (ca. 25 persons). All salamanders were released following capture. Two U. S. Forest Service biologists (Lohofener and Jones, 1991) reported finding six specimens (out of a total of nine) along the Ouachita National Recreation Trail (vic. sites 7 and 8) during survey work (which included 21 total sites) in November 1990. Site 1 yielded five specimens in April, 1980; at that time, a National Forest Road (NFR) permitted access by vehicle to this area. The NFR access no longer exists, and much of the western slope between sites 1 and 2 has undergone exten-

Table 1. Recent locality information (1996-1998) and historic collection site data for the Fourche Mountain salamander, *Plethodon fourchensis*, as shown in Fig. 2.

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
1	Polk	NW¼, NW¼, S10, T1S, R31W	3	4/15/80	ASUMZ 7589, 7597 15113, 15232	Fourche Mtn. (Ouachita National Trail)	N slope, mixed deciduous-pine, scattered rocks, moist
2	Polk	SW¼, NW¼, S11, T1S, R31S	3	4/18/98	-	Fourche Mtn. (Ouachita National Trail)	N slope, mixed deciduous-pine, scattered rocks, dry
3	Polk	SW¼, SW¼, S2, T1S, R31W	3	4/18/98	-	Fourche Mtn. (valley at base of N Slope)	N slope, mixed deciduous-pine, scattered rocks, very dry
6	Polk	NW¼, NE¼, S18, T1S, R30W	3	5/13/97	-	Fourche Mtn. (valley at base of S Slope)	S slope, mixed deciduous-pine, scattered rocks, very dry
7	Polk	NW¼, SW¼, S10, T1S, R30W	3	5/15/98	-	Fourche Mtn. (Ouachita National Trail)	N slope, mixed deciduous-pine, few rocks and logs, dry
8	Howard	SW¼, NE¼, S10, T1S, R30W	2	4/10/82	-	Foran Gap (Ouachita National Trail)	N slope, mixed deciduous-pine, scattered surface rocks
9	Howard	SE¼, NW¼, S10, T1S, R30W	3	10/9/98	-	Fourche Mtn. (1.6 km E Foran Gap)	S slope near stream, mixed deciduous-pine, rocks and logs, moist
10	Polk	SW¼, SE¼, S4, T1S, R30W	3	4/20/97	1	Fourche Mtn. (1.6 km W Ouachita National Trail)	N slope, near stream, mixed deciduous, numerous rocks
				4/13/87	ASUMZ 7276-79		
				5/15/89	ASUMZ 12696-12700		
				10/7/89	ASUMZ 14187		
				4/15/90	ASUMZ 15866		
11	Polk	SW¼, SE¼, S4, T1S, R30W	3	5/3/96	ASUMZ 20982-88	Fourche Mtn. (1.8 km W Ouachita National Trail)	S slope near stream, mixed deciduous, numerous rocks, moist
				4/27/91	ASUMZ 17664-68		
				4/24/93	ASUMZ 18979		
12	Polk	NW¼, NE¼, S10, T1S, R30W	3	5/17/94	17	Fourche Mtn. (0.8 km W Ouachita National Trail)	S slope near stream, mixed deciduous, numerous rocks, logs, moist
				5/3/96	ASUMZ 21261		
				4/19/98	ASUMZ 22674-75		
13	Polk	NW¼, NE¼, S11, T1S, R30W	2,3	5/27/97	-	Fourche Mtn. (4.0 km W Wolf Pinnacle)	S slope, mixed deciduous-pine, rocks and logs, dry
14	Scott	SW¼, NE¼, S26, T1N, R30W	3	4/13/96	-	Ca. 3 km N Fourche Mtn.	SW slope, mixed deciduous-pine, rocks and logs, dry
15	Scott	NE¼, NW¼, S25, T1N, R30W	3	4/3/96	-	Ca 3.5 km N Fourche Mtn.	Creek bottom, SW slope, mixed deciduous-pine, scattered rocks, moist
16	Scott	SW¼, NW¼, S30, T1N, R29W	3	5/27/97	-	Ca 2.5 km N Fourche Mtn.	N slope, mixed deciduous-pine, scattered rocks, dry
17	Scott	NW¼, NW¼, S35, T1N, R30W	3	5/27/97	-	Fourche Mtn. (valley at base of N slope off NFR 807)	N slope, mixed deciduous-pine, scattered rocks, very dry
18	Polk	NW¼, NW¼, S5, T1S, R29W	1	-	-	Fourche Mtn. (Wolf Pinnacle)	
19	Scott	NE¼, NE¼, S35, T1N, R29W	3	5/3/96	-	Ca. 0.5 km N Fourche Mtn.	N slope, mixed deciduous-pine, numerous rocks and boulders, moist
20	Montg.	NW¼, NE¼, S12, T1S, R29W	3	5/15/96	-	Fourche Mtn. (0.5 km SE Blue Mtn.)	S slope, mixed deciduous-pine, rocks and logs, very dry
21	Montg.	SE¼, SE¼, S18, T1S, R28W	3	5/15/96	-	Irons Fork Creek (along NFR 76)	N slope along creek, mixed deciduous-pine, rocks and logs, moist

Table 1. Recent locality information (1996-1998) and historic collection site data for the Fourche Mountain salamander, *Plethodon fourchensis*, as shown in Fig. 2 (continued).

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
22	Montg.	NE¼, SW¼, S8, T1S, R28W	3	5/13/97	-	Fourche Mtn. (Ouachita National Trail)	S slope, mixed deciduous-pine, scattered surface rocks, dry
23	Montg.	SW¼, SE¼, S32, T1N, R28W	3	5/28/97	-	Fourche Mtn. (along Turner's creek)	N slope near creek, mixed deciduous-pine, scattered rocks and logs, moist
24	Montg.	SW¼, SW¼, S15, T1S, R28W	3	5/3/96	1	Irons Fork Creek (along NFR 76)	S slope near stream, mixed deciduous, numerous rocks, moist
25	Montg.	NW¼, SW¼, S1, T1S, R28W	3	5/15/98	ASUMZ 22741	Fourche Mtn. (0.7 km S Buck Knob)	Rocky ridge, mixed deciduous, numerous rocks, logs, dry (salamander in log)
26	Montg.	NW¼, NW¼, S1, T1S, R28W	2,3	5/3/96	ASUMZ 20983	Fourche Mtn. (Buck Knob)	S slope, mixed deciduous-pine, scattered rocks, logs, moist following rain
27	Montg.	SE¼, SW¼, S1, T1S, R28W	3	5/15/98	ASUMZ 22740	Fourche Mtn. (1.0 km S Buck Knob)	N slope/ridge, mixed deciduous-pine, numerous large surface rocks, logs, dry (salamander in log)
28	Montg.	SE¼, NW¼, S13, T1S, R28W	3	10/9/98	-	Fourche Mtn. (along NFR 76, 1.3 km W NFR 76A)	S slope, mixed deciduous, scattered rocks and logs, mostly dry
29	Montg.	SW¼, NWE¼, S23, T1S, R28W	3	10/9/98	-	Fourche Mtn. (0.7 km SE Brushy Knob along NFR 216)	S slope near seepage area, mixed deciduous, numerous rocks, moist
30	Montg.	SW¼, NE¼, S23, T1S, R28W	3	10/9/98	ASUMZ 22843	Fourche Mtn. (0.7 km NE Brushy Knob along NFR 216)	N slope in roadcut, mixed deciduous, numerous rocks, moist
31	Montg.	SW¼, NE¼, S17, T1S, R27W	3	5/26/98	-	Fourche Mtn. (NFR 76, 2.0 km N Mast Mtn.)	N slope/rocky ridge, mixed deciduous-pine, scattered rocks and logs
32	Montg.	NW¼, SE¼, S10, T1S, R27W	3	5/26/98	-	Fourche Mtn. (2.0 km S US Hwy 270; NFR 813)	NE slope, mixed deciduous-pine, scattered rocks and logs, moist

*1 - Duncan and Highton (1989)

2 - Plummer (1982)

3 - This report

sive timber harvesting. Plummer (1982) found a large number ($n = 20$) of *P. fourchensis* on Buck Knob (site 26) during April and May, 1982. Only two specimens were found there on 3 May 1996 during the present study. We were able to collect two specimens from within logs at sites 25 and 27 not far from Buck Knob. The largest reported collection of *P. fourchensis* ($n = 23$) was by Lohofener and Jones (1991) in May 1991 ca. 2 km NW of Buck Knob (Scott Co.) at the end of NFR 218. Plummer (1982) failed to find *P. fourchensis* at three sites along the eastern and middle portions of Irons Fork Mountain. This area was not searched during the present study.

***Plethodon ouachitae*.**—The Rich Mountain salamander is known to occur on Rich Mountain and Black Fork Mountain, two mountains that dominate extreme northwestern Polk County (Figs. 1 and 3). Locality information on *P. ouachitae* is found in Table 2. Three of the nine collection

sites (2, 3, and 4) represent historic collection sites utilized in the past by many collectors of this species (e.g., site 4 = site 3 in Pope and Pope, 1951). Pope and Pope (1951) reported the largest single collection of *P. ouachitae* ($n = 131$; their site 4) in May 1950 near the base of the Rich Mountain fire tower in the area of an old homestead. Lohofener and Jones (1991) visited this site in November 1990 without success. We also visited the fire tower area in recent years, but never attempted to collect there primarily because the surface habitat was heavily overgrown with dense vegetation and was not ideally suited for collecting activities. Three new sites (7, 8, and 9) yielded specimens during the present survey. Typically, the Rich Mountain salamander can be collected in large numbers in late April and early May on the north-to-northwest slope and the ridge top of Rich Mountain; a wet substrate (moist leaf litter around the rocks) and precipitation immediately prior to collection greatly

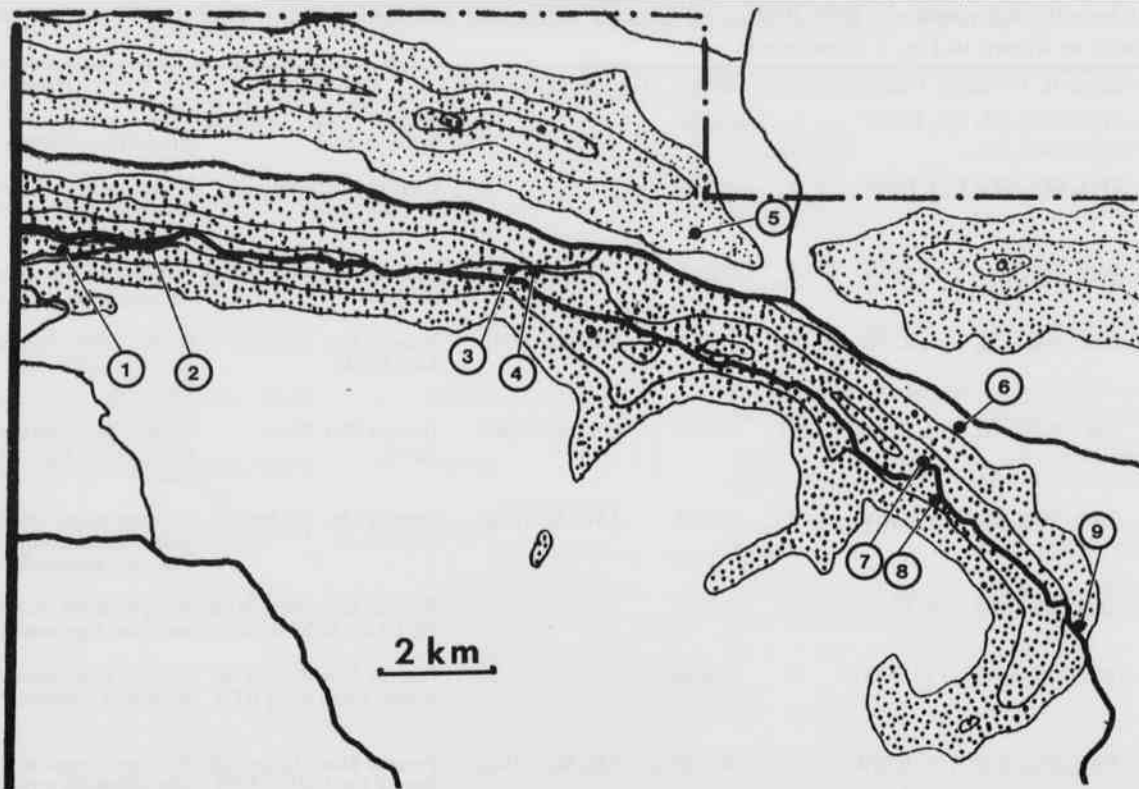


Fig. 3. Map illustrating historic collection sites and/or localities visited during the recent study of *Plethodon ouachitae* in the Rich Mountain area. Outermost contour lines approximate 440 m in elevation; inner contour lines show increases in elevation at increments of ca. 150 m. See Table 2 for explanation of numbered sites.

increase the chances of encountering salamanders beneath rocks. At drier times of the year (when the salamanders seek deeper shelters), breaking into rotting logs often proves to be the best collection method. Pope and Pope (1951) collected 59 specimens in the vicinity of site 4 in late April and early May; over the years, sites 3 and 4 (along St. Hwy 272 as it winds steeply to meet St. Hwy 88 on the top of the mountain) have consistently yielded large numbers of *P. ouachitae*. For instance, during the initial visit to this area in April 1980, the senior author and his students collected 23 specimens and released many others in a short period of time (ca. 45 min.). Most visits to this locality (along the highway) have been conducted in April and last ca. 45 min. A recent visit to site 4 (8 October 1998) yielded four specimens; Lohofener and Jones (1991) reported only one *P. ouachitae* in this area in November 1990. There are several small seeps and ravines along St. Hwy 272; the wet conditions are ideally suited for the Ouachita dusky salamander, *Desmognathus brimleyorum*. On occasion, *P. ouachitae* can be found along the fringe of this moist, mostly-rocky microhabitat. The same can be said about the microhabitat conditions and the occurrence of these two salamanders along NFR 514 (sites 1 and 2). In contrast, Site 7 below Eagleton Vista is more open, exhibits fewer rocks, and is much less

mesic than sites 1-4; however, this area was very productive for salamanders on 18 April 1998. We found three *P. ouachitae* (two vouchers) at site 8 (between 6:16-6:55 pm) on 8 October 1998 in a mostly rocky habitat just off St. Hwy 88. This site was more or less randomly selected to see whether a southwest facing slope would yield salamanders. We uncovered one salamander at site 9 in May 1998. Habitat disruption at this site (east-facing slope) indicated that it had been searched by collectors in the recent past. No *P. ouachitae* were observed at sites 5 or 6 during the present study, although some *P. albagula* were collected. Lohofener and Jones (1991) visited five sites on the east end (north slope) of Black Fork Mountain (to the north and west of site 5) and successfully collected 19 *P. ouachitae* in May 1991.

***Plethodon caddoensis*.**—The distribution of *P. caddoensis* is mostly limited to the Novaculite Uplift area in the Caddo and Cossatot Mountains of southeastern Polk, southwestern Montgomery, and northwestern Pike counties (Blair and Lindsay, 1965). Additional localities are found along the Cossatot River and its tributaries in Howard County (see Figs. 1 and 4). Of the 44 localities shown in Fig. 4, 25 were visited during the recent study period. Of these sites, 17 yielded *P. caddoensis*. The other sites represent historic localities visited between 1980 and 1996. Several records were

Table 2. Recent locality information (1996-1998) and historic collection site data for the Rich Mountain salamander, *Plethodon ouachitae*, as shown in Fig. 3.

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
1	Polk	SW¼, NW¼, S8, T1S, R32W	4	5/14/96	-	Rich Mtn. (NFR 514)	S slope, mixed deciduous, scattered rocks, moist
2	Polk	SW¼, NE¼, S8, T1S, R32W	4	4/27/91	ASUMZ 17676-86	Rich Mtn. (5.4 km W Queen Wilhelmina State Park, along NFR 514)	S slope, mixed deciduous, scattered rocks, moist
				5/14/98	-		
				5/7/94	5		
3	Polk	NW¼, SW¼, S7, T1S, R31W	4	4/12/87	ASUMZ 7346-48	Rich Mtn. (Along St. Hwy 272, vic. edge of Queen Wilhelmina State Park)	N slope, mixed deciduous, wet ravine, rocks, wet
				4/15/90	ASUMZ 15859/63		
				5/27/98	ASUMZ 22761-64		
4	Polk	NE¼, SW¼, S7, T1S, R31W	4	6/5/80	ASUMZ 15111	Rich Mtn. (Along St. Hwy 272)	N slope, mixed deciduous, scattered large rocks, moist
				9/30/83	ASUMZ 7435		
				3/15/84	ASUMZ 7592		
				4/27/85	ASUMZ 5333-37		
				4/11/87	ASUMZ 7173-75		
				4/11/87	ASUMZ 7393-7408		
				4/15/89	ASUMZ 12791-12808		
				8/7/89	ASUMZ 15274		
				10/7/89	ASUMZ 14192-93		
				4/24/93	ASUMZ 18863-18927; 18967-74		
				3/18/94	ASUMZ 19615-36		
				4/19/97	ASUMZ 21756-73		
			2	May 1991	(See text)		
			2	11/19/90	(See text)		
			4	4/28/90	23 (See text)		
5	Polk	NW¼, NW¼, S9, T1S, R31W	4	5/27/98	-	Black Fork Mtn. (Along Ouachita National Trail)	S slope, mixed deciduous-pine, scattered rocks, dry
			1	-	(See text)		
			2	May 1991	(See text)		
6	Polk	NW¼, SW¼, S14, T1S, R31W	4	5/27/98	-	Rich Mtn. (valley at base of mountain near creek)	S slope, mixed deciduous-pine, scattered rocks, moist
7	Polk	NE¼, SW¼, S23, T1S, R31W	4	4/18/98	ASUMZ 22430-40	Rich Mtn. (Eagleton Vista)	NW slope, mixed deciduous, numerous rocks and logs, dry
8	Polk	SW¼, SE¼, S10, T1S, R31W	4	10/8/98	ASUMZ 22816-17	Rich Mtn. (0.6 km E Eagleton Vista, St. Hwy 88)	S slope, mixed deciduous, scattered rocks, moist
9	Polk	NE¼, SW¼, S31, T1S, R30W	4	5/28/98	ASUMZ 22764	Rich Mtn. (0.5 km SE Blue Haze Vista, St. Hwy 88)	E slope near ridge crest, mixed deciduous-pine, scattered rocks and logs, moist

*1 - Blair and Lindsay (1965)

2 - Ren Lohofener and Robert L. Jones, 17-21 Nov., 1990; 8-16 May, 1991 (unpublished locality data)

3 - Pope and Pope (1951)

4 - This report

drawn from the scientific literature, whereas others represent localities unpublished by other investigators.

Talus-covered slopes within the Caddo Mountains are the preferred habitat of *P. caddoensis*. Typically, the talus is comprised of drifts of loose gravel to small-to-medium sized rocks. The occurrence of *P. caddoensis* in abandoned mines has been reported by several authors (e.g., Saugey et al.,

1985; Heath et al., 1986; Saugey et al., 1988). Two mine sites (5 and 6) were visited during the present study. Wet conditions were not suitable within the Twin Mines site for habitation by *P. caddoensis* on 19 April 1997. This site typically contains large numbers of this species, especially during the egg-laying season of mid-to-late summer. Rocks and loose talus along Brushy Creek near the mouth of Pipistrelle Mine

Table 3. Recent locality information (1996-1998) and historic collection site data for the Caddo Mountain salamander, *Plethodon caddoensis*, as shown in Fig. 4.

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
1	Polk	NW¼, SW¼, S11, T3S, R31W	3	4/19/97	ASUMZ 21631-33	Low water bridge on Clear Fork/Twomile Creek	NE slope, mixed deciduous-pine, scattered rocks along stream, moist
2	Polk	SE¼, NE¼, S9, T3S, R30W	3	4/19/97 5/4/96	- -	Along Carter Creek (St. Hwy 375)	N slope, mixed deciduous-pine, along stream, moist
3	Polk	NW¼, SE¼, S13, T3S, R31W	2	-	-	Bee Mtn. Tower off NFR	N slope, deciduous, talus
4	Polk	NW¼, NE¼, S33, T3S, R30W	3	4/19/97	-	Along NFR 56	W slope, deciduous, talus, moist
5	Polk	SE¼, NW¼, S27, T3S, R30W	3	4/19/97 8/24/90 8/7/89	- ASUMZ 16789-16802 ASUMZ 15239-61	Vicinity Twin Mines (along NFR 56)	S slope, mixed deciduous-pine, along creek and in mines, moist
6	Polk	SE¼, NW¼, S27, T3S, R30W	3	4/19/98	ASUMZ 21679-85	Pipistrelle Mine (along stream at base of N slope)	N slope, mixed deciduous-pine, scattered rocks, wet
7	Polk	S27, T3S, R30W	-	4/29/88	ASUMZ 11176-84	Sugarstick Mine	-
8	Howard	NE¼, NW¼, S26, T5S, R30W	2	-	-	St. Hwy 4 at Cossatot River	N slope, deciduous, talus, very wet
9	Howard	SE¼, SWE¼, S24, T5S, R30W	3	4/15/89 4/27/91	ASUMZ 12758 ASUMZ 17643-44	St. Hwy 4 at Baker Creek (south side of bridge)	N slope, mixed deciduous-pine, scattered surface rocks
10	Polk	NW¼, NSW¼, S24, T4S, R30W	3	5/11/97	ASUMZ 21824-29	Along NFR 402 (0.8 km W jct. 402 & 605)	N slope, mixed deciduous-pine, rocks and logs, dry
11	Polk	NW¼, SW¼, S32, T3S, R28W	3	5/12/97	ASUMZ 21821-22	Along NFR 38-1 (1.9 km E jct. 38-1 & 95)	N slope near seep, mixed deciduous, numerous rocks, moist
12	Polk	NE¼, SW¼, S34, T3S, R29W	3	5/4/96	ASUMZ 21227	Along Mine Creek	N slope, mixed deciduous-pine, along creek, scattered rocks, moist
13	Polk	SW¼, SW¼, S33, T3S, R29W	3	5/4/96	ASUMZ 21254-66	Along Little Missouri River	N slope, mixed deciduous-pine, rocks and large, dry
14	Polk	SE¼, NW¼, S7, T4S, R28W	3	5/12/97	ASUMZ 21820	Along NFR 38 (edge of Caney Creek Wilderness Area)	NW slope near creek, mixed deciduous-pine, numerous rocks, logs, moist
15	Polk	NE¼, SE¼, S18, T4S, R28W	3	5/12/97	ASUMZ 21842	Caney Creek Trail at NFR 64	SW slope near stream, mixed deciduous, numerous rocks, logs, moist
16	Polk	NW¼, NE¼, S30, T4S, R30W	3	5/11/97	ASUMZ 21831	Along NFR 64 (4 km S jct 106 & 38)	Creek bottom, SW slope, mixed deciduous pine, scattered rocks, moist
17	Polk	NW¼, NE¼, S30, T4S, R30W	2	-	-	Shady Lake Rec. Area	Gentle slopes, mixed deciduous-pine, scattered surface rocks
18	Polk	SW¼, NW¼, S21, T4S, R28W	3	5/21/97	ASUMZ 21841	Along NFR 106 (1.4 km E jct. 106 & 38)	S slope, mixed deciduous-pine, along creek, moist
19	Polk	NE¼, NE¼, S26, T4S, R27W	3	5/11/97	ASUMZ 21832-33	Along NFR 106	S slope, mixed deciduous-pine, scattered rocks, moist
20	Montg.	NE¼, NE¼, S35, T1N, R29W	3	5/12/97	ASUMZ 21804	St. Hwy 8 at Pittman Creek (upstream from bridge)	W slope, mixed deciduous-pine, numerous rocks and boulders, creek dry
21	Montg.	SW¼, SE¼, S5, T4S, R27W	3	5/4/96	ASUMZ 21253	Along Crooked Creek	S slope, mixed deciduous-pine, rocks and logs, very wet
22	Montg.	NW¼, NW¼, S4, T4S, R27W	2	-	-	Slatington Tower (off NFR 43A)	N slope, deciduous, talus, scattered small seeps
23	Montg.	S26, T3S, R27W	3	7/8/92	ASUMZ 18519-20	Cox Spring	-

Table 3. Recent locality information (1996-1998) and historic collection site data for the Caddo Mountain salamander, *Plethodon caddoensis*, as shown in Fig. 4 (continued).

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
24	Montg.	NW¼, NW¼, S4, T4S, R27W	3	5/4/96	ASUMZ 21228-30	Caddo River at St. Hwy 8 (upstream from bridge)	NW slope, streambed, leaf litter, moist
25	Montg.	NE¼, NE¼, S31, T3S, R26W	3	4/24/93	ASUMZ 18862-64; 18886-96	Along St. Hwy 8 (old homesite)	N slope near dump site, mixed deciduous, numerous rocks, moist
26	Montg.	SE¼, NW¼, S33, T3S, R26W	3	4/19/98 5/11/97 5/28/97 10/8/98	ASUMZ 22562-22614 ASUMZ 21861-62 ASUMZ 21887-94 ASUMZ 22805-09	0.8 km S St. Hwy 8, off NFR 73	E slope, mixed deciduous-pine, embankment along stream
27	Montg.	SE¼, SW¼, S5, T4S, R26W	3	5/11/97	ASUMZ 21842	Bank along creekbed	S slope, mixed deciduous-pine, scattered rocks, logs, moist
28	Montg.	NE¼, SE¼, S12, T4S, R27W	2	-	-	Pass between Statehouse Mtn. and Polk Creek Mtn.	N slope, mostly deciduous-pine, talus scattered surface rocks, TYPE locality
29	Montg.	SW¼, NW¼, S22, T4S, R27W	3	5/11/97	1	Along NFR 73 (step talus slide)	W slope, mixed deciduous, numerous rocks, mostly moist
30	Montg.	NE S30, T4S, R27W	1	11/17-21/90	5	Vicinity Albert Pike Rec. Area	-
31	Montg.	NW¼, SE¼, S12, T1S, R29W	3	5/3/93	ASUMZ 18984-86	Indian Quarry (ca. 3 km W Albert Pike Rec. Area)	-
32	Montg.	NW¼, NW¼, S27, T4S, R27W	2	-	-	Albert Pike Rec. Area	N slope along Little Missouri River, deciduous, talus
33	Montg.	NE¼, SW¼, S8, T1S, R28W	4	5/25/31/95	4	0.96 km E Albert Pike Rec. Area (north side of road)	-
34	Montg.	SW¼, NE¼, S19, T4S, R26W	2	-	9	9.6 km NE Albert Pike Rec. Area (County rd. 4)	N slope, deciduous, talus
35	Montg.	SW¼, SW¼, S14, T3S, R25W	3	10/8/98	-	3.5 km E St. Hwy 8 along Montgomery Creek (NFR 177)	N slope, deciduous, along creek
36	Montg.	SW¼, SE¼, S13, T3S, R25W	3	10/8/98	-	1.3 km E Crystal Rec. Area along Montgomery Creek (NFR 177)	N slope near creek mixed deciduous, numerous rocks, moist
37	Montg.	NW¼, NE¼, S17, T3S, R24W	3	10/8/98	-	0.6 km N Collier Spring Rec. Area along Collier Creek (NFR 177)	N slope, mixed deciduous-pine, scattered rocks and logs, wet
38	Montg.	S13, T4S, R25W	5	-	1	Caddo Gap (western face of gap)	E slope of gap, mixed deciduous-pine, steep slope, under log
39	Montg.	S13, T4S, R25W	2	5/10/82	2	Caddo Gap (E side of St. Hwy 8)	N slope, mixed deciduous, scattered rocks
40	Montg.	NW¼, SE¼, S17, T4S, R24W	3	5/10/97	-	Along Gap Creek (1.6 km E St. Hwy 8)	NW slope along creek, mixed deciduous-pine, talus
41	Montg.	NE¼, SE¼, S17, T4S, R24W	3	5/10/97	ASUMZ 21861-62	Along Gap Creek (2.4 km E St. Hwy 8)	W slope, wet ravine, mixed deciduous-pine, scattered rock
42	Montg.	SW¼, NE¼, S17, T1S, R27W	3	4/27/80	ASUMZ 5650	Along Gap Creek (4 km E St. Hwy 8)	S slope, mixed deciduous-pine, talus, mostly dry
43	Pike	SE¼, NE¼, S10, T5S, R24W	3	3/13/87	ASUMZ 6851-53	Caddo River (just downstream US Hwy 70 bridge)	N slope, talus

Table 3. Recent locality information (1996-1998) and historic collection site data for the Caddo Mountain salamander, *Plethodon caddoensis*, as shown in Fig. 4 (continued).

Locality	County	Section, Township, Range	*Source	Date	Voucher Specimens	Description	Habitat
44	Pike	SE¼, NE¼, S6, T5S, R27W	3	3/13/87	ASUMZ 6851-53	Along Little Missouri River	-

- *1 - Ren Lohofener and Robert L. Jones, 17-21 Nov., 1990; 8-16 May, 1991 (unpubl. locality data)
- 2 - Plummer (1982)
- 3 - This report
- 4 - Carl Anthony, 25-31 May 1995 (unpubl. locality data)
- 5 - Pope and Pope (1951)

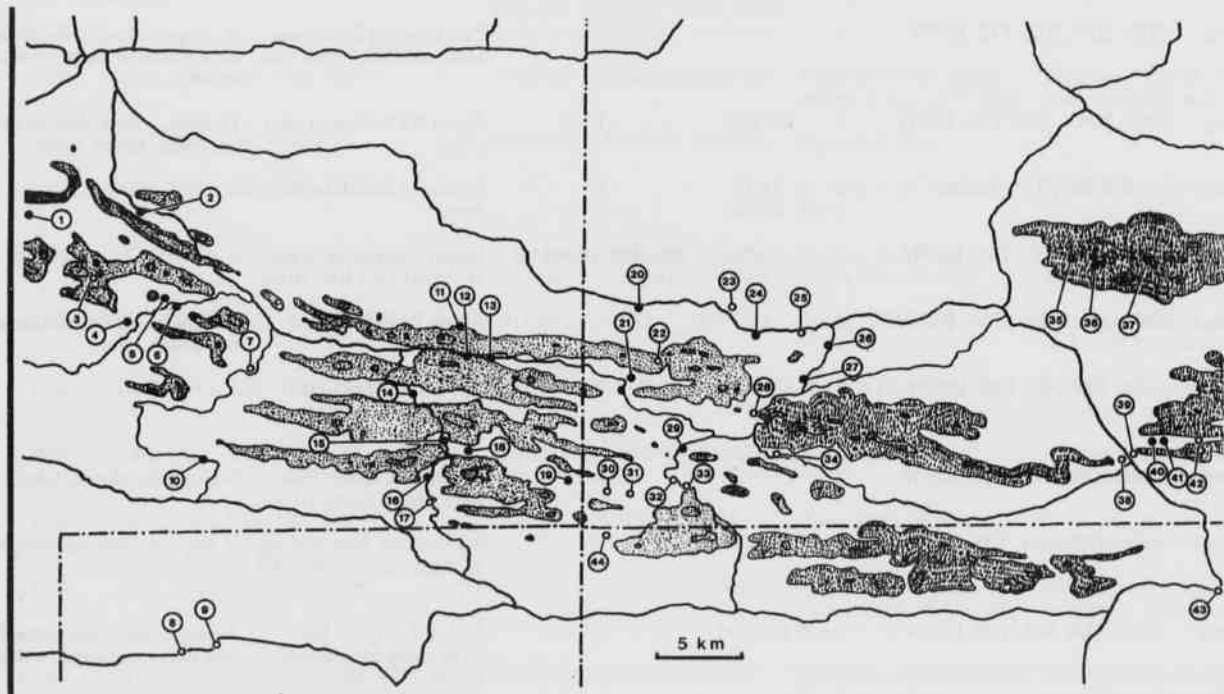


Fig. 4. Map illustrating historic collection sites and/or localities visited during the recent study of *Plethodon caddoensis* in the Caddo Mountains area. Outermost contour lines approximate 440 m in elevation (western mountainous region) and 300 m in elevation (eastern mountainous region); inner contour lines show increases in elevation at increments of ca. 150 m. See Table 3 for explanation of numbered sites.

yielded seven specimens on 19 April 1998. The salamander was also easily found in the vicinity of an old homestead and associated dump area along St. Hwy 8 (site 25) on 24 April 1993. (This site no longer exists following the construction of a new home.) Leaf litter along the dry creekbed of the upper reaches of the Caddo River (site 24) contained a number of *P. caddoensis* and several many-ribbed salamanders (*Eurycea m. multiplicata*) on 4 May 1966. The largest number of *P. caddoensis* collected by Plummer (1982) from a single site was 19 individuals at Albert Pike Recreation Area (site 32) on 4 April 1982. By comparison, five sites yielded 10-12 specimens in a survey by Lohofener and Jones (1991) in

May 1991. Our largest single collection of this species occurred during a third visit to site 26 on 19 April 1998; a total of 52 *P. caddoensis* was collected in a very limited stretch of habitat along a small creek. Four visits to this site during 1997-1998 yielded a total of 69 specimens.

Plummer (1982) searched for *P. caddoensis* at three sites in the Crystal Mountains region just northeast of Norman (Montgomery Co.) without success. We were unable to find this species in three habitat situations within this eastern mountainous area. The Gap Creek populations (sites 41 and 42) indicate that the range of this species probably extends well into the White/Strawn Mountain region and possibly

Table 4. Salamander diversity observed at localities visited during recent survey work (1996-1998) in the Ouachita Mountains of Arkansas. (PF = *P. fourchensis*, Pa = *P. albagula*, Ps = *P. serratus*, Em = *Eurycea multiplicata*, Db = *Desmognathus rimleyorum*).

Locality	Salamander Species (<i>P. fourchensis</i> study)					Salamander Species (<i>P. ouachitae</i> study)					Salamander Species (<i>P. caddoensis</i> study)				
	Pf	Pa	Ps	Em	Db	Po	Pa	Ps	Em	Db	Pc	Pa	Ps	Em	Db
1	0	5	0	0	0	0	0	0	2	2	3	0	3	0	2
2	0	7	8	1	0	0	0	0	4	4	0	1	0	0	2
3	0	0	0	0	0	5	10	0	0	0	0	0	0	0	0
4	0	0	0	0	0	25	15	6	29	29	0	1	1	0	1
5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
6	0	4	0	0	0	0	4	0	1	1	7	0	3	1	3
7	0	0	0	0	0	11	3	6	0	0	0	0	0	0	0
8	5	4	0	0	0	3	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
10	8	13	21	3	1					6	0	0	0	0	0
11	2	3	6	4	0					2	0	0	0	0	0
12	0	0	0	0	0					1	0	1	0	0	0
13	0	0	0	0	0					4	0	1	0	0	0
14	0	2	1	0	0					1	1	0	0	0	0
15	0	0	0	0	1					2	0	0	0	0	0
16	0	1	0	0	0					1	0	0	0	0	0
17	0	1	0	0	0					0	0	0	0	0	0
18	0	0	0	0	0					1	0	0	0	0	2
19	0	1	0	0	0					2	0	4	1	0	0
20	0	0	1	0	0					1	2	0	0	0	0
21	0	2	1	0	0					1	0	1	0	0	0
22	0	1	2	0	0					0	0	0	0	0	0
23	0	0	0	0	0					0	0	0	0	0	0
24	0	3	1	0	0					2	0	2	7	0	0
25	1	0	2	0	0					0	0	0	0	0	0
26	0	1	1	0	0					69	5	39	10	0	0
27	1	0	0	0	0					1	0	0	0	0	0
28	0	0	1	0	0					0	0	0	0	0	0
29	0	0	3	0	0					1	0	0	1	0	0
30	1	0	1	0	0					0	0	0	0	0	0
31	0	2	0	0	0					0	0	6	1	0	0
32	0	1	0	0	0					0	0	0	0	0	0
33										0	0	0	0	0	0
34										0	0	0	0	0	0
35										0	2	0	0	0	0
36										0	3	0	0	0	0
37										0	6	1	0	0	0
38										0	0	0	0	0	0
39										0	0	0	0	0	0
40										3	1	0	0	0	0
41										0	5	3	0	1	0
42															
43															
44															
Totals	18	43	41	4	2	45	34	12	1	36	108	27	65	21	11

into the Sharp Top Mountain area. The collection site at Glenwood (site 43), however, represents the southeasternmost locality known for this species. Site 1 represents the northwesternmost locality known for this species.

Ecological Associates and Habitat Preferences.--During the course of this study, several additional plethodontid salamanders were collected (Table 4) and included the following species: the southern redback salamander (*P. serratus*) and three species previously mentioned [the western slimy salamander (*P. albagula*), the many-ribbed salamander (*E. m. multiplicata*), and the Ouachita dusky salamander (*D. brimleyorum*)]. Kuss (1986) reported that *P. fourchensis* and *P. oua-*

chitae seemed to prefer higher slopes compared to *P. albagula*, a salamander of comparable size. He also suggested that no clear difference in habitat preference existed between *P. caddoensis* and *P. albagula*. Although we have searched in a number of disturbed areas along U.S. Hwy 270 in the past (along railroad tracks at Eagleton and the community of Rich Mountain as well as old homesteads and dump sites in the vicinity of the two communities), we have never collected *P. ouachitae* in habitats other than within the well-forested, rocky areas specifically on the higher slopes or at the top of Rich Mountain. Indeed, we have found *P. albagula*, *P. caddoensis*, and *P. fourchensis* at all elevations and in sev-

eral different microhabitats (beneath rocks, in or beneath logs, and in leaf litter); various authors have indicated that the degree of surface moisture strongly influences the catchability rates in all of these *Plethodon* (Spotila, 1972). *Plethodon fourchensis* seems to be the least tolerant to low substrate moisture levels (i.e., microclimate directly beneath surface rocks), whereas *P. albagula* appears to be the most tolerant. Although a considerable amount of excavation during dry weather is required to collect *P. caddoensis*, this kind of effort is normally successful simply because the surface rocks are usually small and, therefore, can be moved to a greater degree than large rocks. On occasion, we have had to resort to this mode of collection to obtain *P. caddoensis*. This kind of effort is rarely successful for *P. fourchensis* or *P. ouachitae*, primarily because removal of surface rocks does not penetrate into the subterranean niches of these salamanders. *Plethodon serratus*, the smallest plethodontid encountered in this study, is commonly found under rocks, within leaf litter beneath logs, and within logs themselves. This species is often observed in small aggregates, especially within logs. In sympatric rocky habitats, *P. serratus* often shares a common subterranean niche with *P. caddoensis*.

The occasional collection of *Desmognathus brimleyorum* in drier niches several m away from their normal semi-aquatic or aquatic (stream) habitats indicated a marginal habitat overlap between this species and the various *Plethodon* species. As stated previously, the relatively large number of *D. brimleyorum* collected on Rich Mountain resulted from a deliberate attempt to thoroughly search small ravines on this mountain. During dry weather, this type of collecting produced an occasional *P. ouachitae*.

The surprising collection of *P. caddoensis* within moist leaf litter within the drying creekbed of the upper Caddo River at site 20 indicated a small degree of habitat sympatry between this species and the normally semi-aquatic/aquatic *E. m. multiplicata*. The presence of *P. caddoensis* away from normal talus conditions can possibly be explained by the occasional flooding of optimal riparian habitats upstream from this site. Salamander eggs, hatchlings, juveniles, and even adults could easily be wafted downstream. This could also help explain why this species has been found at sites 8 and 9 (along Cossatot River) and on the cliff banks above the Caddo River at Glenwood (site 43). These are areas a considerable distance outside of the Novaculite Uplift area.

Summary.—The present study surveyed populations of three species of plethodontid salamanders in the genus *Plethodon* that occur in the Ouachita National Forest of southwestern Arkansas. Although new localities were discovered for each species, none occurred outside its currently recognized range. In general, all three species were easy to collect during the spring months, especially following several days of moderate-to-heavy precipitation. These salamanders were very difficult to obtain in rocky habitats during dry weather of late summer and fall. *Plethodon*

fourchensis was the least abundant of the three species and was observed in both low and high elevation rocky habitats on Fourche Mountain and on parts of Irons Fork Mountain. *Plethodon ouachitae* was common at the higher elevations on Rich Mountain, but probably occurs in rocky habitats at lower elevations. *Plethodon caddoensis* was the most common of the three species and was the easiest to collect at lower elevations throughout the Caddo and Cossatot Mountains.

Recommendations.—Insuring the survival of a salamander species through time in a managed forest ecosystem requires the protection of the most basic of all natural resources, a suitable environment in which to live. Success in managing plethodontid salamander populations will depend upon the willingness of ecosystem managers to preserve the integrity of selected physical habitats. The following statements and/or guidelines represent a summary of desirable conservation biology for the three salamanders in question:

- 1) Understand that the most critical requirement for the overall future survival of each of the three species is maintaining large tracts of healthy, unaltered forest and stream-side habitat within each species' range in Ouachita National Forest.

- 2) Establish and abide by a highest conservation priority; i.e., limiting large-scale forest habitat and stream degradation during timber harvesting.

- 3) Determine the appropriate level and method for timber removal that will allow current populations of these salamanders to remain healthy.

- 4) Continue studies using forested experimental plots designed to examine new or improved silvicultural practices and their effects on salamander populations, especially those within mountainous slopes.

- 5) Monitor populations on a routine basis as an integral part of the management plan for each species.

Because these salamanders are currently locally abundant and have already been given some degree of protection, they should not be regarded as endangered or even highly vulnerable to immediate threats. And, if landscape protection remains at its current priority level, there appears to be no imminent fear of any of these species precipitously declining in number in the near future.

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