Distribution, Life History Aspects, and Conservation Status of the Mena Crayfish, *Orconectes* (*Procericambarus*) *menae* (Decapoda: Cambaridae)

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The Mena crayfish, *Orconectes* (*Procericambarus*) *menae* (Creaser) is an endemic crayfish of the Ouachita Mountains physiographic province of Oklahoma and Arkansas. Originally described from a tributary of the Irons Fork of the Ouachita River at Mena, Polk County, Arkansas, *O. menae* has now been reported from additional sites in Polk and Montgomery counties, Arkansas, and LeFlore and McCurtain counties, Oklahoma. This crayfish inhabits areas under rocks and rubble both in swifter, shallow runs and in shallow pool margins of clear streams (stream order 1-3) where rocks and rubble frequent. Form I males were found in mid-March to June. We document several new localities for *O. menae* as well as providing a summation of all known localities for the species. In addition, various aspects of the biology of *O. menae* are discussed. We recommend a conservation status of threatened for *O. menae*.

INTRODUCTION

The Mena crayfish, *Orconectes* (*Procericambarus*) *menae* (Creaser) is an endemic decapod of the Ouachita Mountains physiographic province of Oklahoma and Arkansas. This crayfish was originally described as *Faxonius menae* by Creaser (1933) from a tributary of the Irons Fork of the Ouachita River at Mena, Polk County, Arkansas. Since then, Williams (1954) reported 158 specimens of *O. menae* from Montgomery and Polk counties, Arkansas, and Reimer (1968) reported a specimen from LeFlore County, Oklahoma. The Nature Conservancy lists *O. menae* with a global rank of G3 (vulnerable to extirpation or extinction) (NatureServe 2009); state conservation ranks are S3 (vulnerable) for Arkansas (NatureServe 2009) and S2/S3 (imperiled/vulnerable) for Oklahoma (E. A. Bergey, 2007, pers. observ.). Little was known about the distributional limits of this species and even less about its natural history, including ecology, reproductive biology, habitat characteristics, and general biology. Limited previous collecting of this endemic form is primarily responsible for this lack of knowledge. This study was initiated to

learn more about *O. menae* and to assess the conservation status of this crayfish.

Specific objectives of the study were (1) to determine the relative abundance and precise distributional limits of the range of *O. menae*; (2) to gather data on life history aspects of this crayfish species including information on habitat, reproductive period, and any other biological data available; (3) to document data on ecological and habitat characteristics of this crayfish species; and (4) to assess the current conservation status of *O. menae* based on the collected distributional data.

MATERIALS and METHODS

Field work was conducted between 2002 and 2004 and between 2006 and 2008. A total of 146 collections in Polk and Scott counties in Arkansas and LeFlore and McCurtain counties in Oklahoma were made during the study. Much of the field work occurred during the fall, spring, and summer. A variety of collecting methods were used in this study, including the use of aquatic dipnets, seines, and baited and unbaited crayfish traps. Most individuals were released unharmed at the collecting site; representative specimens were preserved in 60% isopropyl or ethyl alcohol for later study at Southern Arkansas University (SAU) or the University of Oklahoma (OU). The number of specimens (Appendix) are the number of specimens preserved (historical data and the 2002 to 2004 surveys) or the total number found at a site (2006 to 2008 surveys). Preserved vouchers were deposited in the SAU Invertebrate Collection, the OU crayfish collection, and the Brigham Young University (BYU) crayfish collection.

Physicochemical conditions were measured at a site in Polk County, Arkansas, where *O. menae* is common. Physiochemical conditions measured were: pH, water temperature, dissolved oxygen, chloride, alkalinity, dissolved solids, specific conductance, total dissolved solids, discharge, and turbidity (Standard Methods 2005). Additionally, pH, water temperature, and conductivity were measured at several of the Oklahoma sites.

In addition to collections made during this survey, museum specimens housed at the United States National Museum of Natural History (USNM 2009) and SAU were used to document the distribution of *O. menae*. Previous literature dealing with this crayfish species was also consulted. Both our survey and historical collection locations were converted to latitude-longitude for mapping (Figure 1).

RESULTS AND DISCUSSION

Our surveys found 316 specimens of *O. menae* in 36 of 146 (25%) localities during the present study (see Appendix). Fifty-one specimens of *O. menae* were collected at eight sites in LeFlore County, Oklahoma, 248 specimens were taken at 23 sites in Polk County, Arkansas, and 17 specimens were collected at five sites in McCurtain County, Oklahoma (Appendix). This crayfish was found under rocks and rubble both in the swifter, shallow runs and the shallow pool margins of clear streams (stream order 1-3) where rocks and rubble were frequent. It also seemed to prefer the more shallow pool margins and runs of upland streams.

Recognition Characters of *O. menae*

The rostrum of *O. menae* is wide with blunt lateral spines and branchiostegal spines are absent. The areola is open and the antennal scale is widest at the point anterior to the mid-length. The first pleopod terminates in two elongate processes of which the central projection is longer and bent slightly caudad at the distal end. Creaser (1933) provided a line drawing of the gonopod of Form I and II males of *O. menae*. In addition, Williams (1954) and Hobbs (1989) figured the gonopod, carapace, antennal scale, chela and carpus, and annulus ventralis of *O. menae*.

The coloration of *O. menae* can be best described as a small tan to brownish cray-

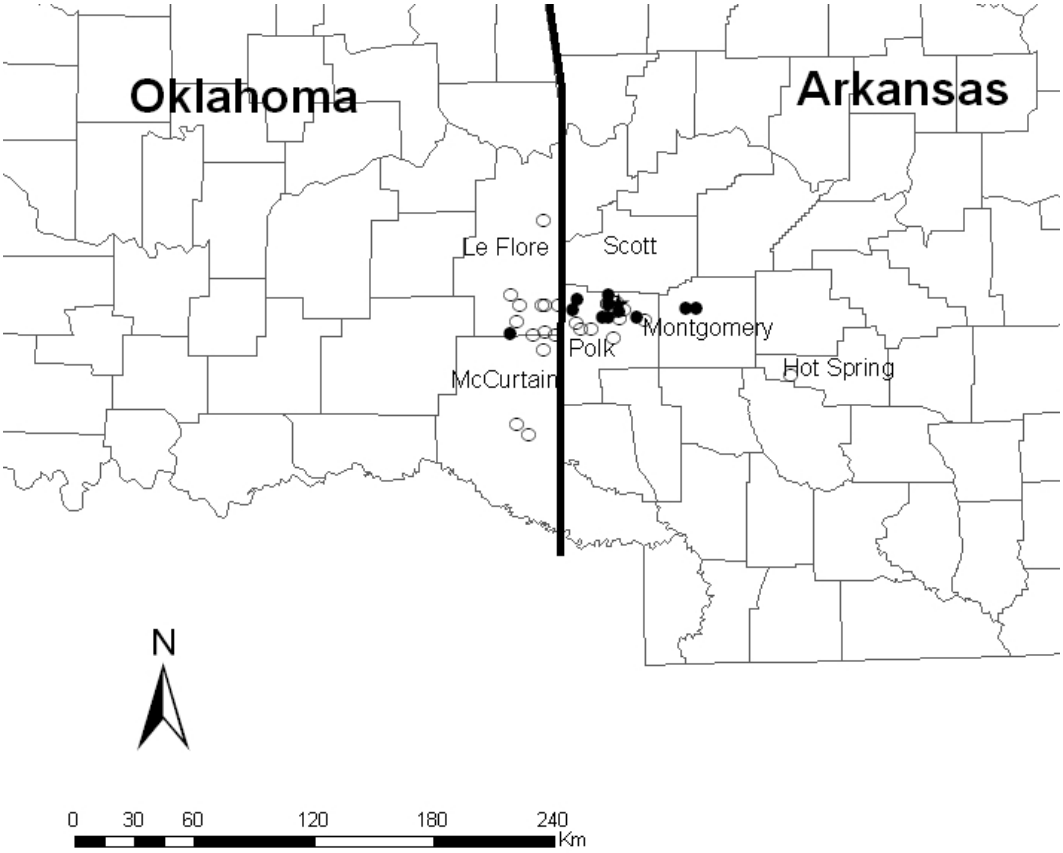

Figure 1. County records of *Orconectes menae*. Type locality (star); previously published records (solid circles); new records (open circles).

fish with slight vermiculations across the carapace. Reimer (1968) reported that the tips of the chelae of *O. menae* are light orange but without conspicuous black markings. Williams (1954) also provides a description of the coloration of *O. menae*.

Taxonomic Remarks

Creaser (1933) reported that *O. menae*, having a short posterior section of the carapace and with a general shape of the chelae, suggested a relationship with the reticulate crayfish, *Orconectes erichsonianus* (Faxon) of Alabama, Georgia, Tennessee, and Virginia. Pending on-going DNA analyses of *O. menae* by K. Crandall at BYU, no additional systematic works has been published to date on this species.

Type Locality

Creaser (1933) reported the type locality of *O. menae* was a "stream tributary of the Irons Fork of the Ouachita River at Mena, Polk County, Arkansas." The holotype is deposited in the Museum of Zoology, University of Michigan as MCZ 53301, collected by E. P. Creaser on 8 July 1931. In addition, Creaser (1933) designated six specimens from a small tributary of the Little Buffalo River near Diamond Cave, 3.5 mi (5.6 km) W of Jasper, Newton County, Arkansas (MCZ 53304) as conspecific with specimens of *O. menae* from the type locale. However, Williams (1954) reported these specimens are not conspecific with *O. menae* but are specimens of the ringed crayfish (*Orconectes neglectus*), and we empathically concur.

Habitat

Williams (1954) found *O. menae* under rocks and rubble in streams in both swift flowing and quiet regions. He also reported

this species from shallow burrows under rocks. Reimer (1963) collected this crayfish under rocks in clear, shallow, flowing streams. In this study, *O. menae* was found under rocks and rubble both in the swifter, shallow runs and the shallow pool margins of clear streams (stream order 1-3) where rocks and rubble are frequent. Occasionally, specimens were located in burrows under the largest rocks or at the side of large rocks. Specimens of *O. menae* were collected from the larger riverine portions of the upper Ouachita River where pool reaches average 9.1 to 15.2 m wide, but typically they occupied the smaller portions of the upper system where spring-fed tributaries are 0.9 to 14.9 m wide. This species was not collected in springs or roadside ditches.

Physicochemical Conditions

The upper Ouachita River at Acorn, Polk County, Arkansas, where *O. menae* is common, was characterized physicochemically by water temperatures ranging from near 0°C in winter to 25°C in summer, dissolved oxygen values of 7.2 to 11.9 mg/l, pH of 7.3 to 7.8, chloride of 0.8 to 2.7 mg/l, alkalinity of 56 to 86 mg/l, dissolved solids of 25 to 84 mg/l, specific conductance of 60 to 134 μS/cm, total dissolved solids of 25 to 84 mg/l, and discharge generally less than 19.8 m^3/sec. Turbidity was generally less than 25 Jackson Turbidity Units (range 25 to 150 JTU) although periods following flooding in the fall and spring, values as high as 150 JTU were recorded. At this site, there are normally no prolonged period of turbid conditions.

Collection site information from Oklahoma indicated that *O. menae* is found in circumneutral waters (pH ranged from 7.0 to 7.5; n = 4 sites), in summer water temperatures as high as 26°C (n = 4 sites), and in low conductivity waters (range: 17.4 to 62.8 μS/cm and mean = 35.3 μS/cm; n = 6 sites). All Oklahoma sites were forested with little or no apparent disturbance.

Distribution

Orconectes menae was known previously from Montgomery and Polk counties, Arkansas in the upper Ouachita River system, and from the Little River system in Polk County, Arkansas and LeFlore County, Oklahoma. During this study, 146 collections were made in the study area of Montgomery, Polk, and Scott counties in Arkansas, and LeFlore and McCurtain counties in Oklahoma. Of the 93 total crayfish collections, *O. menae* was found at 36 localities (25% of sampling sites) of which 23 were in Arkansas and 13 were located in Oklahoma (Appendix). While numerous new localities for *O. menae* were found during this study, all of them were located either within the upper Ouachita River system of Arkansas or the upper Little River system in Arkansas and Oklahoma (Figure 1). Although several potential sites were visited in southern Scott County, Arkansas, no *O. menae* were found to occur there.

In Oklahoma, this is the first publication of *O. menae* from McCurtain County. The first known collection was three specimens taken 9.7 km NNE of Broken Bow on 28 November 1963 and deposited in the US National Museum of Natural History (USNM 118749, see Appendix). This survey added five additional McCurtain County sites. Thus, McCurtain County is added to LeFlore County as part of the distribution of this crayfish in Oklahoma. Eight sites are documented in tributaries of the Little/Mountain Fork watershed of LeFlore County for *O. menae* (Appendix).

In Arkansas, counties that support populations of *O. menae* lie within the heart of the Ouachita Mountain physiographic province. Thirteen specimens of *O. menae* were historically reported from Montgomery County and a total of 418 specimens were found in Polk County (Appendix).

A search of USNM records yielded a noteworthy collection of two specimens of *O. menae* from a stream on the west boundary of Lambert, on St. Hwy. 84, Hot Spring County, Arkansas, collected by H. H. Hobbs, Jr. and Kearney on 30 April 1976 (Appendix,

Figure 2). This site represents the easternmost known locality for *O. menae* and is in the Caddo River drainage. One of us (CTM) visited this site on 28 August 2009 and found that, although the site (Figure 2) fits well with descriptions of locales that support *O. menae*, no *O. menae* were collected. Three red spotted stream crayfish (*O. acares*), a species associated with *O. menae*, were collected. As the last, and only known, collection was 33 years previously, we do not know whether *O. menae* persists at this site.

In addition to our survey, 15 additional collections (n = 144 specimens) housed in the USNM (Appendix) were used to document the overall distribution of this species. The USNM data comprised 15 sites in Arkansas, including the only two in Montgomery County (n = 13 specimens) and 13 locales in Polk County (n = 131 specimens).

Life History Aspects

Creaser (1933) collected Form I and II males and females on 8 July 1931. Form I males have also been previously reported in June (Reimer 1963). In this study, Form I males were found in mid-March to June. Also, Form II males have been taken in April, May, and June. Ovigerous females were collected in April and May; however, no females with young have been collected.

Decapod Stream Associates

Crayfishes found commonly associated with *O. menae* in Arkansas included *O. acares*, the Little River crayfish (*O. leptogonopodus*), the western painted crayfish (*O. p. longimanus*), and the Ouachita Mountain crayfish (*Procambarus tenuis*). Interestingly, these crayfishes are also associates found with *P. tenuis* (Robison and McAllister 2008). In Oklahoma, associates were *O. p. longimanus* at almost every *O. menae* site and *P. tenuis* at one site.

Conservation Status

Taylor et al. (2007) designated *O. menae* as a "threatened" species, which was defined as a species or subspecies likely to become endangered throughout all or a significant portion of its range. Our discovery of 316 individuals of *O. menae* across a four county area (Polk and Montgomery counties in Arkansas and LeFlore and McCurtain counties in Oklahoma) establishes this stream crayfish as relatively abundant

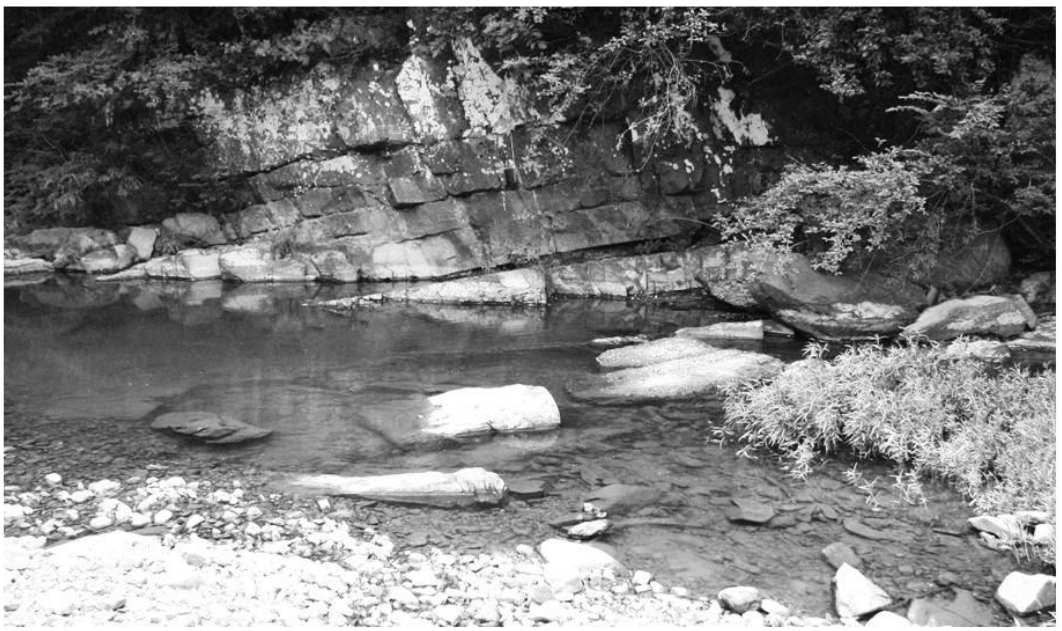

Figure 2. Historical 1976 study site (Big Hill Creek) of *Orconectes menae* in Hot Spring County, Arkansas. Photo taken by CTM on 10 September 2009.

in part of the range (Polk County - with 37 known collection sites) and less abundant in it's range outside of Polk County.

Because our survey inadequately covered the eastern portion of the historic range of *O. menae* in Montgomery and Hot Spring counties, we were unable to assess its current status in these counties. Additional surveys are warranted, especially because our one attempt to recollect *O. menae* at the known historic site in Hot Spring County was not successful nor were attempts that were made at the two historic sites in Montgomery County.

Orconectes menae is found in only the upper Little River and upper Ouachita River system in the Ouachita Mountains of Arkansas and Oklahoma. The species occurred in forested, little or undisturbed rocky streams. Our survey supports the "threatened" conservation status of *O. menae* because of this restricted distributional range and association with high quality habitat. Because the highest population density is in Arkansas, the state conservation ranks of S3 (Arkansas) and S2/S3 (Oklahoma) are appropriate.

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APPENDIX. Known locations of 580 specimens of *Orconectes menae* in Oklahoma and Arkansas (locality [latitude/longitude in decimal degrees when available, as estimated from collection locations], date of collection, collector, and number of specimens, if known).

OKLAHOMA (72 specimens)
LEFLORE COUNTY (52 specimens)
1. Little Eagle Creek, W of Octavia (34.5206°N, 94.7391°W). Unknown date. R.D. Reimer. USNM 114315 (1).
2. Cucumber Creek (34.5728°N, 94.7005°W). 18 June 2002. S.N. Jones, J. Waterbury and D.B. Fenolio. 3.
3. Richmond Creek (34.6453°N, 94.4728°W). 19 March 2003. S.N. Jones. 3
4. Richmond Creek at St. Hwy. 63 (34.5728°N, 94.6829°W). 6 April 2008. HWR. 7.
5. Rock Creek (34.51161°N, 94.61635°W). 17 March 2004. S.N. Jones. 3.
6. Turkey Creek (34.52133°N, 94.54700°W). 17 March 2004. S.N. Jones. 6.
7. Pigeon Creek at St. Hwy. 63, ca. 5 mi (8.0 km) W of OK/AR line (34.6453°N,94.5428°W). 5-6 April 2008. HWR. 21.
8. Billy Creek at Billy Creek Recreation Area (34.6898°N, 94.7330°W). 4 April 2008. HWR. 3.
9. Horsepen Creek at St. Hwy. 63, ca. 1 mi (1.6 km) W of OK/AR line (34.6453°N, 94.6829°W). 5 April 2008. HWR. 5.

MCCURTAIN COUNTY (20 specimens)
1. 6 mi (9.7 km) NNE Broken Bow at Yanubbee Creek. 28 Nov. 1963. A.P. Blair. USNM 118749. (3).
2. Luksuklo Creek (35.0223N, 94.5477W). 20 July 2002. S.N. Jones, J. Waterbury and D. B. Fenolio. 1.
3. Cow Creek (34.50677°N, 94.49362°W). 17 March 2004. S.N. Jones. 5.
4. Cooper Creek (34.06450°N, 94.64561°W). 11 May 2004. S.N. Jones and Jackson. 4.
5. Dry Panther Creek (34.44398°N, 94.55394°W). 17 July 2004. S.N. Jones and M. Le. 5.
6. Big Eagle Creek (34.48996°N, 94.16846°W). 17 July 2004. S.N. Jones and M. Le. 2.

ARKANSAS (508 specimens)
HOT SPRING COUNTY (2 specimens)
1. Stream (Big Hill Creek) on W boundary of Lambert on St. Hwy. 84 (34.3086°N, 93.2079°W). 30 April 1976. H.H. Hobbs, Jr. and Kearney. USNM 147216 (2).

MONTGOMERY COUNTY (13 specimens)
1. Little Brushy Creek, 0.5 mi (0.8 km) E of Oden (34.6187°N, 93.2079°W. 5 Sept. 1948. A.B. Leonard. USNM 132952 (10).
2. Ouachita River, 6 mi (9.7 km) NW of Mt. Ida (34.6196°N, 93.7103°W). 5 Sept. 1948. A.B. Leonard and A.B. Williams. USNM 132953 (3).

POLK COUNTY (493 specimens)
1. **TYPE LOCALITY:** Tributary of the Irons Fork of the Ouachita River at Mena (34.6474°N, 94.1347°W). 8 July 1931. E. P. Creaser. MCZ 53301 (holotype), 53302 (allotype), 53303 (paratypes) (5).
2. Tributary to Ouachita River, 2.1 mi (3.4 km) E of Cherry Hill (34.5842°N, 94.0388°W). 4 Sept. 1948. A.B. Leonard and A.B. Williams. USNM 132955 (2).
3. Ouachita River, 0.5 mi (0.8 km) E of Acorn (34.6445°N, 94.1947°W). 4 September 1948. A.B. Leonard and A.B. Williams. USNM 132956 (38).

4. Tributary to Ouachita River at Mena (34.5864°N, 94.2288°W). 4 September 1948. A.B. Leonard and A.B. Williams. USNM 132957 (37).
5. Irons Fork, 5.9 mi (9.5 km) E of Mena (34.6148°N, 94.1383°W). 4 September 1948. A.B. Leonard and A.B. Williams. USNM 132958 (21).
6. Tributary to Ouachita River, 4.6 mi (7.4 km) E of Ink (34.5881°N, 94.1909°W). 4 September 1948. A.B. Leonard. USNM 132951 (9).
7. Rock Creek, 9 mi (14.5 km) W of Mena (34.5592°N, 94.3768°W). 2 October 1948. A.B. Leonard. USNM 132959 (3).
8. 5.7 mi (9.2 km) S of Scott County line (no further data). 18 April 1973. H.H. Hobbs, Jr. USNM 144618 (1).
9. Unnamed stream ca. 5 mi (8.0 km) NE of Mena off St. Hwy. 88 and jct. of St. Hwy. 77 (34.644°N, 94.198°W). 18 April 1973. H.H. Hobbs, Jr. USNM 144623 (1).
10. Tributary to Irons Fork River, ca. 7 mi (11.3 km) NE of Mena at jct. of St. Hwy. 88 and St. Hwy. 77 (34.655°N, 94.1527°W). 18 April 1973. H.H. Hobbs, Jr. USNM 144626 (5).
11. Tributary to Irons Fork River on Posey Hollow Rd., ca. 1 mi (1.6 km) E of US 71 and 4.5 mi (7.2 km) NE of Acorn (34.6877°N, 94.1940°W). 20 April 1973. H.H. Hobbs, Jr. USNM 144630 (4).
12. Small tributary to Mountain Fork River, 10 mi (16.1 km) WNW of Mena (34.6191°N, 94.3941°W). 2 October 1948. A.B. Leonard. USNM 132950 (8).
13. 2.4 mi (3.9 km) N of Ink on dirt rd. 24 September 1981. Franz and Puckett. USNM 178386 (2).
14. 9.5 mi (15.3 km) NW of Mena (34.6716°N, 94.369°W). 25 March 1951. A.B. Williams. USNM 132949 (2).
15. Ouachita River at Acorn off US Hwy. 71 (34.6427°N, 94.1983°W). 5 May 2006. HWR, K. Crandall and J. Buhay. 26.
16. Ouachita River at Co. Rd. 74 at steel bridge (34.6094°N, 94.1778°W). 20 October 2006. HWR. 29.
17. Rock Creek NW of Mena at St. Hwy. 8 (34.537°N, 94.2968°W). 18 November 2006. HWR. 6.
18. West Fork of Powell Creek (34.537°N, 94.3499°W). 9 December 2006. HWR. 5.
19. Irons Fork of Ouachita River at St. Hwy. 88, 5.5 mi (8.9 km) E of Mena (34.5804°N, 94.1373°W). 16 February 2007. HWR. 19.
20. Ouachita River ca. 3 mi (4.8 km) NE of Mena at gravel road (34.6094°N, 94.1728°W). 24 March 2007 and 11 April 2007. HWR. 5, 21.
21. Ouachita River 0.5 mi (0.8 km) S of Cherry Hill (34.5712°N, 93.9955°W). 12 April 2007 and 30 April 2007. HWR. 11, 21.
22. Ouachita River on NFR road, ca. 1.5 mi (2.4 km) W of Acorn (34.6528°N, 94.2436°W). 12 April 2007. HWR. 17.
23. Ouachita River ca. 4 mi (6.4 km) NW of Acorn at U. S. Hwy. 270 (34.6817°N, 94.1728°W). 15 March 2007. HWR. 20.
24. Irons Fork of Ouachita River at St. Hwy. 88 (Sec. 7, T2S, R29W). 22 April 2007. HWR. 32.
25. Lewis Creek at gravel road (34.6238°N, 94.1905°W). 23 April 2007. HWR. 10.
26. Ouachita River ca. 5 mi (8.0 km) SE of Ink (34.566°N, 94.0664°W). 30 April 2007. HWR. 1.
27. Irons Fork of Ouachita River ca. 5 mi (8.0 km) E of Acorn off Posey Hollow Road (34.6528°N, 94.1019°W). 4 March 2008. HWR. 32.
28. Irons Fork of Ouachita River ca. 7 mi (11.3 km) E of Acorn (34.6528°N, 94.0664°W). 15 March 2008. HWR. 10.

29. Irons Fork of Ouachita River ca. 5 mi (8.0 km) NE of Mena (34.6383°N, 94.1373°W). 15 March 2008. HWR. 18.
30. Sulphur Creek at St. Hwy. 8, ca. 1.5 mi (2.4 km) E of Board Camp (34.537°N, 94.0664°W). 21 October 2007. HWR. 2.
31. Mountain Fork River ca. 5 mi (8.0 km) W of Rocky at gravel road (34.6378°N 94.4378°W). 24 October 2007. HWR. 6.
32. Mill Creek at St. Hwy. 8, ca. 10 mi (16.1 km) W of Mena (34.6094°N, 94.4031°W). 24 November 2007, 27 December 2007 and 4 May 2008. HWR. 4, 4, 5.
33. Collins Creek at St. Hwy. 8, ca. 10 mi (16.1 km) W of Mena (34.6383°N, 94.4208°W). 24 November 2007. HWR. 4.
34. Powell Creek at St. Hwy. 8 at Rocky (34.5949°N, 94.3676°W). 25 November 2007. HWR. 9.
35. Balan Creek at St. Hwy. 88, ca. 1.5 mi (2.4 km) E of Pine Ridge (34.5857°N, 93.9252°W). 24 March 2008. HWR. 13.
36. Brushy Creek at St. Hwy. 88, 0.5 mi (0.8 km) E of Oden (34.6147°N 93.7672°W). 28 December 2007. HWR. 7.
37. Ouachita River S of Pine Ridge (34.5857°N, 93.8901°W). 26 April 2008. HWR. 18.