

## The Relict Darter, *Etheostoma chienense* (Percidae): Status Review of a Kentucky Endemic<sup>1</sup>

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### ABSTRACT

The distribution, microhabitat affinity and availability, and conservative estimates of numbers of *Etheostoma chienense*, the relict darter, were assessed. All known historical sites and sites in nearby drainages that might harbor the species were surveyed. The relict darter is endemic to the Bayou du Chien drainage, Graves and Hickman counties, Kentucky, where it is most abundant in Jackson Creek and a limited reach of upper Bayou du Chien near the town of Water Valley. The species has a decided affinity for undercut banks and adjacent narrow (<4 m), shallow (<25 cm), moderately flowing (<0.3 m/sec) runs underlain with sandy gravel. At the 5 sites yielding the species, estimates of the extent of suitable habitat ranged from <5 to 110 m of stream. Suitable cover and spawning habitat were deemed primary limiting factors for the species. Given its limited distribution and apparent dependence on one spawning area, the relict darter is extremely vulnerable to anthropogenic activities.

### INTRODUCTION

The relict darter, *Etheostoma chienense* Page and Ceas, a recently described member of the *Etheostoma squamiceps* complex (subgenus *Catonotus*, family Percidae), is endemic to the Bayou du Chien drainage of western Kentucky (1). Because the species is restricted in distribution and has a limited spawning area, it is being considered for federal listing as an endangered or threatened species (2, 3). We summarize here the findings of a status survey of the relict darter (2) including a near-comprehensive review and summary of the literature related to its taxonomy, biology, and distribution.

### MATERIALS AND METHODS

All known contemporary and historical literature regarding the relict darter was reviewed and relevant findings summarized or

referenced herein (see Appendix I for summary of all known historical sites). In 1991, selected localities in Bayou du Chien and Obion Creek drainages, Kentucky, were surveyed for the relict darter using standard minnow seines and dip nets (see Appendix II for complete locality data on sites surveyed or reconnoitered). Institutional acronyms are given in Appendix I and follow Leviton et al. (4) and Leviton and Gibbs (5).

To characterize the habitat of the relict darter, we measured stream width, depth, and velocity at the site of capture as well as the overall channel width. Velocity was determined by repeatedly timing a submerged object over a given distance. Substrate and cover at each capture site also were recorded.

### RESULTS

*Taxonomy and Synonymy.*—The relict darter is one of 10 recognized species in the *Etheostoma squamiceps* complex of the subgenus *Catonotus* and is the sister species to a monophyletic group comprised of *E. pseudovulatum*, *E. neopteronum*, and *E. oophylax* (1). The relict darter was first recognized as a distinct taxon by Page et al. (1), although apparently

<sup>1</sup> As this article went to press the U.S. Fish and Wildlife Service determined the relict darter to be Endangered under the authority of the Endangered Species Act of 1973 (Fed. Reg. 58(246):68480-68486).

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it was first discovered in Bayou du Chien by Webb and Sisk (6; reported as *E. squamiceps*). In other publications, the relict darter has been included in the synonymy of the spottail darter (*E. squamiceps*) by Burr (7), Page (8), Kuehne and Barbour (9), and Page (10); and the lollypop darter (*E. neopteron*) by Braasch and Mayden (11), Burr and Warren (12), and Page and Burr (13). Distinguishing features of the subgenus *Catonotus* and the *E. squamiceps* complex, as well as a complete description and illustrations of the relict darter, were provided by Page et al. (1). Braasch and Mayden (11) also provided illustrations of the species (as *Etheostoma neopteron*, see 11, Figs. 2b and 13, upper half-tone).

**Distribution.**—The relict darter is known only from the Bayou du Chien system in western Kentucky (Appendix I). Bayou du Chien is a small primarily sand and mud bottomed Coastal Plain stream in extreme western Kentucky that drains about 554 km<sup>2</sup> (12). To provide perspective on the likelihood of persistence or occurrence of the relict darter in other drainages, we note that previous survey work in surrounding drainages, including Clarks River (14, 15) and Obion River (16 and records at SIUC, UT, INHS) failed to reveal any species possibly representing the relict darter. Moreover, the immediately adjacent drainages of Mayfield and Obion creeks have failed to yield the species. Historical collections from Mayfield and Obion creeks were made by Woolman (17) at Hickory Grove and Cypress, Kentucky, respectively, but no species representing the subgenus *Catonotus* were reported by him. Smith and Sisk (18) provided information specifically documenting the fauna of Obion Creek from 39 collections at 21 stations but did not report any species currently placed in the subgenus *Catonotus*.

Our review of records compiled by Burr and Warren (12) and recently updated at SIUC indicate that at least 42 collections are represented for Mayfield Creek, excluding those made in wetlands. Likewise, records for 56 collections (including those in 18) are available for the Obion Creek mainstem and tributaries. We also examined 5 sites in Brushy Creek (Obion Creek drainage) which has its headwaters immediately adjacent Jackson Creek and upper Bayou du Chien and, given this geographical proximity, is a logical area to

TABLE 1. Summary of present and historical distribution localities and numbers of individuals observed of the relict darter, an endemic species of Bayou du Chien in Fulton, Graves, and Hickman counties, Kentucky. Localities are arranged from upstream to downstream (complete locality information is referenced by site number and/or catalog number in Appendix I and II). ND = not determined; NA = not available.

Locality	Number of Individuals	
	1991	Pre-1991
Bayou du Chien (Site 2, NE Water Valley)	5	NA*
Bayou du Chien (Hwy 45)	ND	NA*
Jackson Cr. (Site 1)	18	100+
Bayou du Chien (Site 3, Hwy 1283)	46	2
Bayou du Chien (Site 4, Hwy 307)	2	3
Sand Creek (Hwy 307)	0	NA*
Bayou du Chien (Site 5, Davis Rd.)	1	2
Little Bayou du Chien (Hwy 239 bridge)	0	NA*
Bayou du Chien (UT 91.2839, N of Moscow)	0	1

\* Webb and Sisk (1975), specimens unavailable.

search for the species. However, of the 5 sites visited, 3 were completely dry, and relict darters were not collected from the remaining 2 (see Appendix II).

Within the Bayou du Chien drainage, the downstream-most locality known from previous collections of the relict darter is in the vicinity of Moscow, Hickman County (but see following) (Table 1). The upstream-most locality is from Bayou du Chien, NW of Water Valley (Table 1, Site 2). This site in Jackson Creek has been surveyed by us and others (Appendices I and II) in March, April, August, and September, and consistently has yielded numerous relict darters. Our survey revealed only 1 other locality (Site 3) that harbored the species in abundance (Table 1). Site 3 previously has yielded only 1 individual (INHS 68008, Appendix I).

**Habitat and Population Density.**—We attempted to quantify the habitat affinities of the relict darter at the 5 sites in our survey that yielded the species (Table 2). At most sites, the species was associated with slow flow, undercut banks (and associated root mats), and substrates of fine gravel mixed with sand and overlain with leaf litter. At sites along the mainstem of Bayou du Chien, the species showed a decided affinity for undercut banks

TABLE 2. Microhabitat characteristics of the relict darter. Site numbers are referenced in Appendix II. D = mean depth, nearest cm (range in parentheses); W = mean width, nearest 0.1 m (range in parentheses); CW = maximum stream channel width, nearest 0.1 m; V = velocity, m/sec; No. = number of individuals captured; cover, predominant type; substrate, predominant type.

Site	D	W	CW	V	No.	Cover	Substrate
1	9 (3-18)	2.5 (2.1-2.8)	2.8	0.04	18	Undercut bank	Gravel/sand
2	10 (3-16)	3.0 (2.0-4.0)	4.0	0	5	Undercut bank	Gravel/sand
3	18 (9-26)	2.5 (2.0-3.2)	13.0	0.29	46	Undercut bank	Gravel/sand
4	13 (8-15)	11.0 (10-12)	12.0	0.48	2	None	Sand/mud/gravel
5	22 (9-32)	2.0	12.0	0.55	1	Undercut bank	Gravel

adjacent narrow (2-3 m) side channels underlain by gravel mixed with sand.

For sites at which the relict darter was most abundant, we attempted to estimate the extent (i.e., length in meters) of suitable habitat available. At Site 1, we estimated 7 individuals for every 10 meters of suitable habitat. Of the 150-m reach examined at this site, about 110 m provided suitable habitat for the relict darter. Extrapolating, we estimated (conservatively) that 80 individuals may occupy the site (i.e., about 75 m upstream and downstream of the bridge). At Site 3, 36 individuals were taken within a 15-m reach of stream consisting of a narrow channel adjacent an undercut bank lined with root mats. Of the 100-m reach examined at Site 3, approximately 50 m appeared to comprise excellent habitat for the relict darter; hence, 120 individuals (conservatively) could occupy the site (i.e., about 50 m upstream and 50 m downstream of the bridge). At sites where few individuals were taken, we estimated extent of suitable habitat as follows: Site 2, <15 m; Site 4, <5 m; Site 5, 15 m. These estimates exclude intervening reaches of these streams that were not surveyed because of limited access and may be confounded by concentrations of individuals at specific points at some sites (e.g., Sites 1 and 3) or capture of one or 2 individuals in non-specific habitats (e.g., Site 4). However, suitable habitat does not appear to be uniformly distributed in tributaries of Bayou du Chien or the mainstem but is patchy and localized in the system.

*Ecology.*—Presently, little is known of the ecology of the relict darter, other than its affinity for undercut banks of small creeks and its use of the undersides of sticks and logs for attachment of eggs. Other *Catnotus* generally use slab rocks for spawning. However, infor-

mation is available on the ecology of other members of the *E. squamiceps* complex (10, 19, 20), all of which undoubtedly share similar life history attributes.

Within the Bayou du Chien system, only 1 spawning area has been identified (viz., Site 1) (1). In our survey, the species was associated in upper reaches with creek chub, *Semotilus atromaculatus*, and blackspotted topminnow, *Fundulus olivaceus*. Additional frequent associates in the mainstem Bayou du Chien included the saddleback darter (*Percina ouachitae*), suckermouth minnow (*Phenacobius mirabilis*), and freckled madtom (*Noturus nocturnus*).

#### DISCUSSION

The endemism of the relict darter in Bayou du Chien is unique. No other fish species shares a similarly restricted distribution anywhere on the northern Gulf Coastal Plain of Arkansas, Kentucky, Missouri, or Tennessee (12, 21, 22, 23). Other species restricted to the northern Gulf Coastal Plain, such as least madtom (*Noturus hildebrandi lautus*) and firebelly darter (*Etheostoma pyrrhogaster*), are unknown in Bayou du Chien and are distributed in 2 or more Mississippi River tributaries. We conclude that it is extremely unlikely that additional populations of the relict darter will be discovered outside the immediately adjacent drainage area of Bayou du Chien given the following: (1) the habitat affinities of the relict darter; (2) the complete allopatry between it and its closest relatives (i.e., *E. oophylax*, *E. pseudovulatum*, and *E. neopteron* all occur to the east in the Tennessee River drainage); (3) the absence of any other species in the *E. squamiceps* complex in Mississippi River tributaries in Kentucky and Tennessee except the relict darter and *E. cross-*

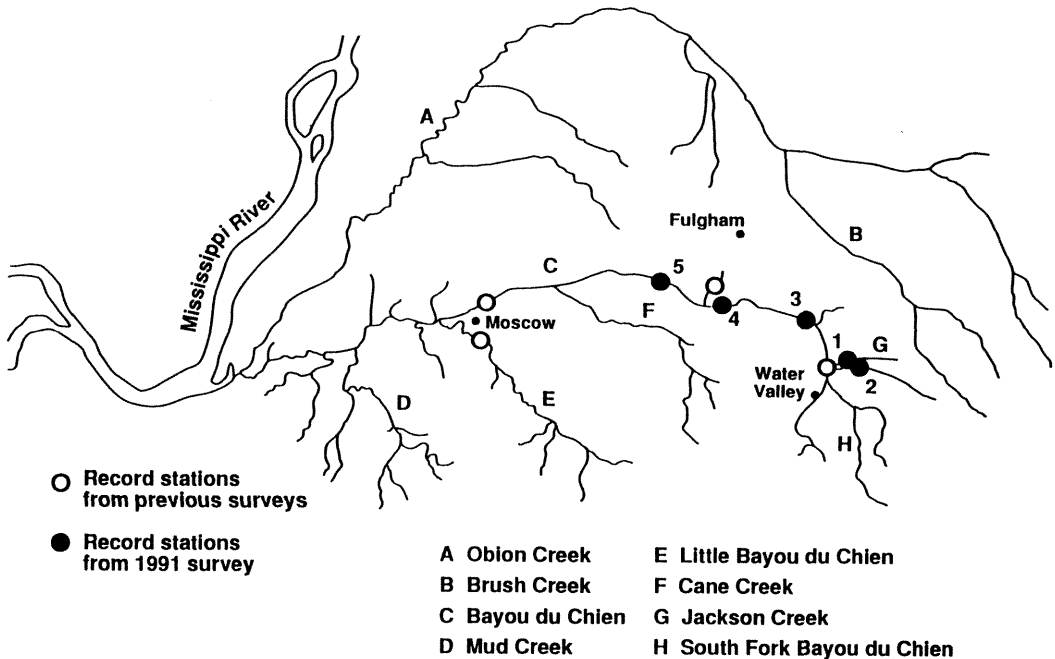


FIG. 1. Localities yielding relict darters (*Etheostoma chienense*) in 1991 (solid circles) and historically (open circles) from Bayou du Chien drainage, Fulton, Graves, and Hickman counties, Kentucky. Complete locality information for positive records as well as all stations surveyed is provided in Appendices I and II. Site numbers are referenced in Tables 1 and 2 and Appendix 1.

*sopterum*; and (5) the availability of summaries of species composition in these drainages that do not record the relict darter (12, 23). As judged from all previous collecting efforts and known distribution of the relict darter, it is clear that the species is restricted to a very limited reach of Bayou du Chien.

As judged from the number of specimens taken in collections from 1972 to 1991 within the Bayou du Chien drainage, the relict darter is most abundant in Jackson Creek (Site 1) and downstream in Bayou du Chien to Site 3 (Table 1, Fig. 1). Although 5 individuals also were taken at Site 2 in isolated pools, the majority of the streambed was essentially dry. Other localities for the relict darter within Bayou du Chien apparently represent either emigrants or waifs from this extremely limited reach of the drainage since numerous visits to sites that yielded 1 or 2 individuals in total generally fail to yield even a single specimen. For example, Site 4 has been sampled at least 10 times by us or colleagues from 1979 to 1991, but only 5 relict darters have been collected from that

site (16 July and 11 November 1980 and this survey). We expended over 3 man-hours seining at this site and captured only 3 relict darters. Likewise, between 1978 and 1991 at least 11 collections were made in Bayou du Chien, Little Bayou du Chien, and their respective tributaries in the vicinity of Moscow, Hickman Co. (Fig. 1), but the only positive records of the relict darter from these downstream reaches are those reported by Webb and Sisk (6; including UT 91.2839, 1 individual). The occurrence of the relict darter outside of the Jackson Creek drainage and reaches of Bayou du Chien immediately downstream of Jackson Creek is highly unpredictable.

In prehistoric times, the relict darter may have been more widespread in Bayou du Chien but still restricted to reaches of the watershed lying upstream of the Mississippi River floodplain (i.e., presently from about Moscow and upstream). Bayou du Chien followed a very sinuous course to the Mississippi River floodplain prior to channelization. Channel sinuosities likely afforded a plethora of both

undercut banks and associated gravel deposits, which as indicated by this survey support most of the relict darters in the drainage (Table 2). Channelization also removed instream cover and spawning substrates as well as riparian vegetation. Channelization and agricultural practices dewatered the floodplains and curtailed perennial flow in many small tributaries which further limited the habitat of the species. Our survey indicates that many small streams in the watershed are completely dry or consist of isolated pools during the early fall months (Appendix II). Both adults and young-of-the-year trapped in isolated pools are subject to increased pressure from predation, exposure to extremes in water temperature, and ultimately total dessication. These observations suggest dispersal of the species upstream of the Jackson Creek area or into many downstream tributaries may be limited by instream flow. If Jackson Creek is the primary area of recruitment, those individuals which do disperse from the tributary may not spawn (or spawn only infrequently) in flowing reaches of Bayou du Chien because of limited spawning substrates. The observed densities, distribution, and microhabitat availability of the relict darter implies that the species is habitat limited, and recruitment may be constrained by limited spawning substrates. The species is now very restricted in the Bayou du Chien drainage and may be dependent primarily on the integrity of one small tributary, Jackson Creek, for continued recruitment.

In short, probable historic reasons that may have restricted the spawning area, habitat, and distributional extent of the relict darter include: channelization of extensive reaches of the mainstem of Bayou du Chien (6) with concomitant homogenization of instream habitat as well as dewatering of floodplain tributaries; ditching of tributaries and removal of shade-producing riparian vegetation and concomitant decrease in habitat and increase in maximum stream temperatures; increased siltation associated with poor agricultural practices; and deforestation and drainage of riparian wetlands with concomitant decreases in instream low flow, especially in potential spawning areas. All of these factors have continued potential to reduce or eliminate the species.

The relict darter has only recently been recognized as distinct and is being considered for

federal conservation status (2, 3). Page et al. (1) recommended that the species be recognized as threatened or endangered nationally because of present or threatened destruction, modification, or curtailment of its habitat or range. The Army Corps of Engineers recently evaluated alternatives to eliminate flooding (e.g., channelization) in the Bayou du Chien watershed and determined that no alternative was cost effective, and the evaluation was terminated (R. R. Cicerello, pers. comm.). Other federal, state, or local government projects that might impact the relict darter or its habitat are unknown at this time. We emphasize, however, that a single accidental chemical or animal waste spill, especially in Jackson Creek, could reduce the population below effective size and render recovery difficult if not impossible. Likewise, any local or individual actions involving modification of the riparian zones or the stream channel could adversely impact the species. Presently, the species receives no state protection, and even if statutory status is invoked, precedents suggest little action will be taken by the state to protect imperiled species or habitats (see Anderson 24). Finally, we implore our ichthyological colleagues to use utmost prudence in collection of the species. The epilogue would be a sorry one indeed if the relict darter became victim to those who would study it.

Notwithstanding potential threats, the presence of apparently healthy populations of the species in Bayou du Chien, even with spawning known from only a limited reach, indicates good potential for recovery of the species. At this point, recovery depends entirely on protection of the Jackson Creek watershed as well as nearby reaches of Bayou du Chien. Addition of spawning habitat (e.g., strategically placed logs or flat rocks) in Bayou du Chien at or near Site 3 (and perhaps other sites) might be a cost-effective means of establishing additional spawning areas and increasing recruitment, population size, and dispersion.

Presently, the only research program concerning the relict darter is the genetic analysis of the species and relatives (P. A. Ceas and L. M. Page, pers. comm.) and our status survey. Research needs on the species include: (1) an autecological study focusing on quantification of seasonal microhabitat preferences and dispersal of different life stages; (2) spring mon-

itoring of Site 3 to determine if spawning actually occurs at or near that reach of Bayou du Chien; (3) identification of additional streams in the Bayou du Chien watershed that could be used to transplant breeding individuals (or guardian males and nests) and ultimately establish additional spawning populations; (4) long-term monitoring of population trends and watershed conditions; and (5) testing the efficacy of addition of spawning substrates to Sites 1 and 3 (or others) in enhancement of recruitment, survival, and dispersion.

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#### APPENDIX I

Summary of all known collection localities of the relict darter prior to this survey. Catalog numbers are followed in parentheses by the number of specimens. Institutional acronyms: INHS, Illinois Natural History Survey; KU, University of Kansas; SIUC, Southern Illinois University at Carbondale; UAIC, University of Alabama Ichthyological Collection; UL, University of Louisville; UMMZ, University of Michigan, Museum of Zoology; USNM, National Museum of Natural History; UT, University of Tennessee; Webb and Sisk (1975), disposition of most specimens reported by these authors (as *E. squamiceps*) is unknown. BAYOU DU CHIEN DRAINAGE: INHS 61720 (33) Jackson Cr., 2.6 km NE Water Valley, on Roy Lawrence Dr., Graves Co., 24 Apr 1986. INHS 63526 (45), as above, 18 Aug 1987. INHS 63920 (21), SIUC 18067 (5), UAIC 9998.01 (5), UMMZ 217893 (5), USNM 313758 (5), UT 91.3849 (5), as above, 7 Apr 1988. INHS 58454 (1), as above, 18 Mar 1990. INHS 58221 (33), as above, 18 Mar 1990. INHS 87178 (1), Bayou du Chien, 4.8 km S Fulgham, Hickman Co., 16 July 1980. INHS 68008 (1), Bayou du Chien, 4.5 km N Water Valley, Hickman Co., 23 Aug 1984. SIUC 1175 (2), Bayou du Chien, same as INHS 87178, at Rt 307, 11 Nov 1980. SIUC 1185 (2), Bayou du Chien, 4.8 km SW Fulgham, Hickman Co., 11 Nov 1980. UL 5992 (1), Bayou du Chien system, Hickman Co. (as *E. neopteron* in Braasch and Mayden 1985). UT 91.2839 (1), Bayou du Chien, 0.8 km NW Moscow, Hickman Co., 7 Aug 1973. KU 20900 (1), Bayou du Chien, N of Water Valley, Graves Co., 5 Apr 1981. Webb and Sisk (1975), Station 9, [Little?] Bayou du Chien, 6.4 km N Cayce at Hwy 239, Fulton Co., day/month unknown, 1972-1973 (this station is either Bayou du Chien at Hwy 239, Hickman Co. or Little Bayou du Chien, at Hwy 239,

Fulton Co.). Webb and Sisk (1975), Station 10, Bayou du Chien, same as UT 91.2839. Webb and Sisk (1975), Station 14, same as SIUC 1185, day/month unknown, 1972-1973. Webb and Sisk (1975), Station 15, same as SIUC 1175, day/month unknown, 1972-1973. Webb and Sisk (1975), Station 16, Sand Cr., 4 km S Fulgham, at Hwy 307, Hickman Co., day/month unknown, 1972-1973. Webb and Sisk (1975), Station 17, same as INHS 68008, day/month unknown, 1972-1973. Webb and Sisk (1975), Station 18, 1.6 km NW [NE?] Water Valley, at Hwy 45, Graves Co., day/month unknown, 1972-1973. Webb and Sisk (1975), Station 19, 3.2 km NE Water Valley, near Bayou du Chien Church, Graves Co., day/month unknown, 1972-1973.

#### APPENDIX II

Sites surveyed and reconnoitered for the relict darter in 1991. A. Catalog numbers and complete locality information for sites yielding relict darters (all Bayou du Chien drainage). Site 1: SIUC 18787, Jackson Cr., 2.6 km NE Water Valley on Roy Lawrence Dr., Graves Co., 21 Sept 1991. Site 2: SIUC 18802, Bayou du Chien, 3.2 km NE Water Valley on Bayou du Chien Rd., 0.4 km S jet. with Roy Lawrence Dr., Graves Co., 21 Sept 1991 (same as Webb and Sisk 1975, station 19). Site 3: SIUC 18759, Bayou du Chien, 4.5 km N Water Valley on Hwy 1283, Graves/Hickman county line, 21 Sept 1991. Site 4: SIUC 18779, Bayou du Chien, at Hwy 307 bridge, 4.8 km S Fulgham, Hickman Co., 21 Sept 1991. Site 5: SIUC 18792, Bayou du Chien, at Davis Rd. bridge, 4.8 km SW Fulgham, Hickman Co., 21 Sept 1991. B. Sites sampled or reconnoitered that did not yield relict darters. Field observations are summarized in parentheses following the locality information. BAYOU DU CHIEN DRAINAGE: Bayou du Chien, at Howell Rd., 5.6 km SW Fulgham, Hickman Co., 21 Sept 1991 (diverse fish fauna, but gravel limited, steep banks, slow current). Bayou du Chien, at Hwy 239 bridge, 0.8 km E Moscow, Hickman Co., 22 Sept 1991 (limited, but suitable, habitat for relict darter, but none taken; diverse fish fauna, many lowland species; gravel limited, good flow, undercut banks present; little spawning habitat available). Bayou du Chien, just N Moscow, Fulton Co., 21 Sept 1991 (mud bottom, no flow, steep

banks, wide stream). Unnamed trib., Bayou du Chien, Hwy 924 bridge, Fulton Co., 18 April 1991 (sand bottom, small). Unnamed trib., Bayou du Chien, at Rose Rd. bridge, 6.7 km SE Fulgham, Hickman Co., 21 Sept 1991 (extreme headwater fish fauna, very small, no current, little gravel, no undercut banks). Browder Cr., at Hwy 166 bridge, Fulton Co., 18 April 1991 (0.6-m wide, sand bottom, no flow). Cane Cr., Hwy 1698 bridge, Hickman Co., 18 April 1991 (littered with solid waste, sand and some gravel). Cane Cr., at Rushton Rd. bridge, Hickman Co., 18 April 1991 (small, sand bottom). Cane Cr., at Hwy 307 bridge, Hickman Co., October 1991 (dry). Cane Cr., at Hwy 924 bridge, Hickman Co., 18 April 1991 (sand bottom, small, dry). Cane Cr., at Cooley Rd. bridge, Hickman Co., 22 Sept 1991 (dry). Cane Cr., at Howell Rd. bridge, Hickman Co., 22 Sept 1991 (dry). Unnamed trib., Cane Cr., at Byrd Rd. bridge, Hickman Co., 22 Sept 1991 (dry). Cane Cr., at Hwy 1529 bridge, 6.4 km E Moscow, Hickman Co., 22 Sept 1991 (lowland stream, primarily mud bottom, turbid water, littered with solid waste, some gravel in one riffle). Little Bayou du Chien, at Hwy 239 bridge, 1.6 km S Moscow, Hickman/Fulton county line, 22 Sept 1991 (lowland stream, soft, mud bottom, little flow, no riffle habitat). Little Bayou du Chien, at Hwy 94 bridge, 3.2 km W Cayce, Fulton Co., 5 Oct 1991 (small bayou with bald cypress, fairly deep, no flow, mud bottom). Little Bayou du Chien, at Hwy 1125 bridge, 5.2 km SSW Buda, Fulton Co., 18 April 1991 (ditched, no flow, mud and sand bottom), 5 Oct 1991 (turbid, mostly mud bottom, no flow, small stream lowland fish fauna). Little Bayou du Chien, Hwy 1907 bridge, Fulton Co., 18 April 1991 (no flow, sand and mud bottom). Little Bayou du Chien, at Thompson Fields Rd. bridge, Fulton Co., 5 Oct 1991 (dry). Unnamed trib., Little Bayou du Chien, Hwy 166 bridge, Fulton Co., 18 April 1991 (no flow, sand and mud bottom). Unnamed trib., Little Bayou du Chien, Hwy 1125 bridge, Fulton Co., 18 April 1991 (small). Mud Cr., Hwy 1127 bridge, Fulton Co., 18 April 1991 (mud and sand bottom). Mud Cr., Hwy 1128 bridge, Fulton Co., 18 April 1991 (little flow, turbid, mud and sand bottom). Mud Cr., at Hwy 94 bridge, 5.6 km W Cayce, Fulton Co., 5 Oct 1991 (very narrow, no flow, steep muddy banks, mud bottom). Pond Br., at Hwy 307 bridge, Hickman Co., 21 Sept 1991 (dry). Rush Cr., at Hwy 94 bridge, Fulton Co. (dry). Sand Cr., at Hwy 307 bridge, 4.2 km S Fulgham, Hickman Co., 21 Sept 1991 (no flow, only isolated pools, nearly dry, no fish collected). Verhine Cr., at Hwy 94 bridge, Fulton Co. 5 Oct 1991 (dry). South Fk. Bayou du Chien, at Pea Ridge Rd., 0.4 km NE Water Valley, Graves Co., 21 Sept 1991 (no gravel, no flow, no undercut banks). OBION CREEK DRAINAGE (all Graves Co.): Brush Cr., at Cuba Rd., 8 km ENE Water Valley, 5 Oct 1991 (almost dry, one pool contained only creek chubs). Brush Cr., at Ira Bell Rd., 6.8 km NE Water Valley, 5 Oct 1991 (closest to headwaters of Bayou du Chien, but almost dry, water turbid, no undercut banks, gravel soft, negligible flow). Brush Cr., at Hwy 58 bridge, 5 Oct 1991 (dry). Barn Cr., at Wingo Rd. bridge 5 Oct 1991 (dry).