

Status of the Arkansas Darter in South-central Kansas and Adjacent Oklahoma

MARK E. EBERLE and WILLIAM J. STARK

Department of Biological Sciences and
Sternberg Museum of Natural History,
Fort Hays State University, Hays, Kansas 67601-4099

ABSTRACT -- We assessed the status of the Arkansas darter (*Etheostoma cragini*) in the Arkansas and Cimarron river basins of south-central Kansas and adjacent areas of Oklahoma. We used data from 145 sites sampled from 1994 through 1997. The Arkansas darter was present at 67 (46%) of these localities, including 26 (67%) of the 39 historic collection localities sampled during our study period. The Arkansas darter was locally abundant and occurred over most of its range in the region; however, dewatering of streams caused by large-scale groundwater withdrawals has resulted in extirpations within the western portion of the study area and poses a threat elsewhere in the region.

Key words: Arkansas darter, Arkansas River Basin, Cimarron River Basin, *Etheostoma cragini*, Kansas fishes, Oklahoma fishes, stream fishes.

The Arkansas darter (*Etheostoma cragini*) is endemic to the middle Arkansas River Basin from eastern Colorado through southwestern Missouri and northwestern Arkansas (Cloutman 1980). There are two geographic regions occupied by the Arkansas darter within its range. One region lies in the Great Plains of southeastern Colorado, southwestern Kansas, and northwestern Oklahoma. The type locality of *E. cragini* (Gilbert 1885) is in this region near Garden City, Kansas, although the species no longer occurs at this site (Cross 1967). Populations in Colorado are now isolated from the main group of populations in Kansas and Oklahoma, but the location of the type locality suggests that its distribution might have been "continuous" prior to EuroAmerican settlement. The other center of distribution is in the Ozark Plateau within the Spring, Neosho (Grand), and Illinois river drainages of southwestern Missouri, southeastern Kansas, northeastern Oklahoma, and northwestern Arkansas. The type locality for *Etheostoma pagei* (Meek 1894), a synonym of *E. cragini*, is located in this region near Neosho, Missouri.

The Arkansas darter typically lives in small streams with clear, cool water (generally less than 25°C) in the vicinity of springs or groundwater seeps with abundant broad-leaved aquatic vegetation (Moss 1981). Usually this habitat is in pools or near-shore areas with little flow and a substrate of sand or gravel, often overlain by silt, leaves, or other organic debris. Larger adults also have been found near undercut banks where terrestrial vegetation extends into flowing water (Taber et al. 1986). On the plains, Moss (1981) suggested that most Arkansas darters occurred where the stream was directly exposed to sunlight, which likely is important for the growth of dense beds of aquatic vascular plants. He also observed habitat segregation of the young and adults. Young Arkansas darters occupied shallow, open areas where spawning occurred, while adults resided in aquatic vegetation.

The Arkansas darter is listed as a protected species by most of the states where it occurs. These states and their respective designations for the Arkansas darter are: Arkansas, vulnerable (rare); Colorado, threatened; Kansas, threatened; and Oklahoma, endangered. Missouri delisted the species, because populations in that state were judged to be stable (Pflieger 1992). Stream degradation caused by livestock has been cited as a threat in Arkansas (Harris and Smith 1985) and could threaten populations elsewhere (Pigg et al. 1985, Pflieger 1992). Specific water pollutants that might pose a threat to the Arkansas darter have not been documented. The principal threat to the Arkansas darter on the Great Plains is the loss of its preferred habitat in small, groundwater-fed streams. Groundwater mining for irrigation and other agricultural operations, sometimes aggravated by periods of drought, has caused several stream reaches in the Great Plains to become ephemeral or intermittent; this, in turn, has led to local extirpations of the Arkansas darter (Cross et al. 1985). The purpose of our study was to assess the status of the Arkansas darter in south-central Kansas and adjacent areas of Oklahoma (Fig. 1). This was done to support a review by the United States Fish and Wildlife Service for the possible inclusion of the Arkansas darter on its list of threatened species.

METHODS and MATERIALS

We obtained information from museum collections, scientific journals, governmental agency reports, and other unpublished sources about previous records of the Arkansas darter. We used this information to prepare maps of the known distribution of the Arkansas darter in south-central Kansas and adjacent areas of Oklahoma. These summaries facilitated the selection of sample localities for our 1997 survey. We chose sample sites with two aims: 1) to determine if the species still occurred in historic stream segments and 2) to clearly define the range of the species within gaps and along the southern periphery of its overall distribution. For our assessment of the status of the Arkansas darter, we were able to sample 100 localities in July 1997. We pooled our data with unpublished information from 45 additional sites sampled between 1994 and 1997 during general stream surveys conducted by

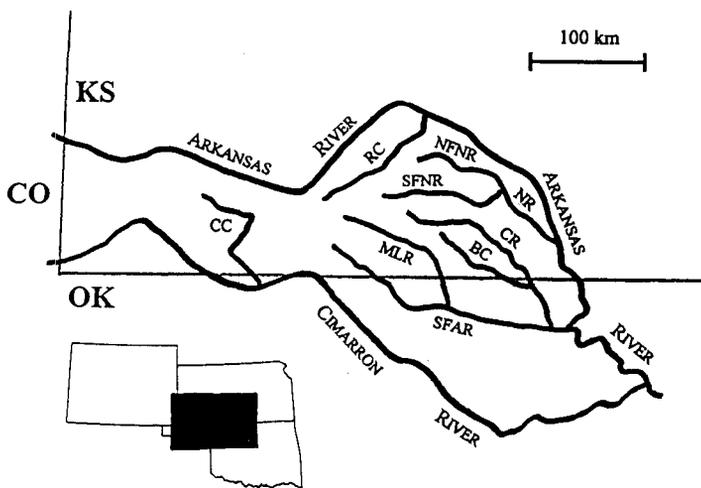


Figure 1. Diagram of streams in the study area in south-central Kansas and adjacent Oklahoma. BC = Bluff Creek, CC = Crooked Creek, CR = Chikaskia River, MLR = Medicine Lodge River, NFNR = North Fork Ninnescah River, NR = Ninnescah River, RC = Rattlesnake Creek, SFAR = Salt Fork Arkansas River, and SFNR = South Fork Ninnescah River.

personnel from Fort Hays State University and the Kansas Department of Wildlife and Parks.

We collected Arkansas darters with dip-nets, because it is difficult to effectively seine or electrofish in the vegetated habitats occupied by this species. At each site, one to three people concentrated their sampling efforts in areas with rooted aquatic vegetation, filamentous algal mats, or overhanging vegetation and roots along the banks. Depending on the extent of suitable habitat, we expended 10 to 45 minutes of sampling effort (number of minutes \times number of people sampling) at each location.

At most sites, we recorded the numbers of "adult" and "young" Arkansas darters, based on two general size classes noted in our samples. At localities with extensive habitat and where we captured Arkansas darters in virtually every dip-net sample, we recorded them as "numerous" (usually more than 100 individuals counted). We took no voucher specimens in consideration of the protected status of the species in Kansas and Oklahoma. We considered misidentification to be unlikely; the only other species of *Etheostoma* in the area is the distinctive orangethroat darter (*Etheostoma spectabile*).

We measured water temperature and specific conductance with a Hach 44600 Conductivity/TDS Meter at most sites where the Arkansas darter was sampled. In addition, we estimated canopy cover as a percentage of the width of the stream channel. We also noted substrate composition and types of aquatic vegetation or other submerged structures.

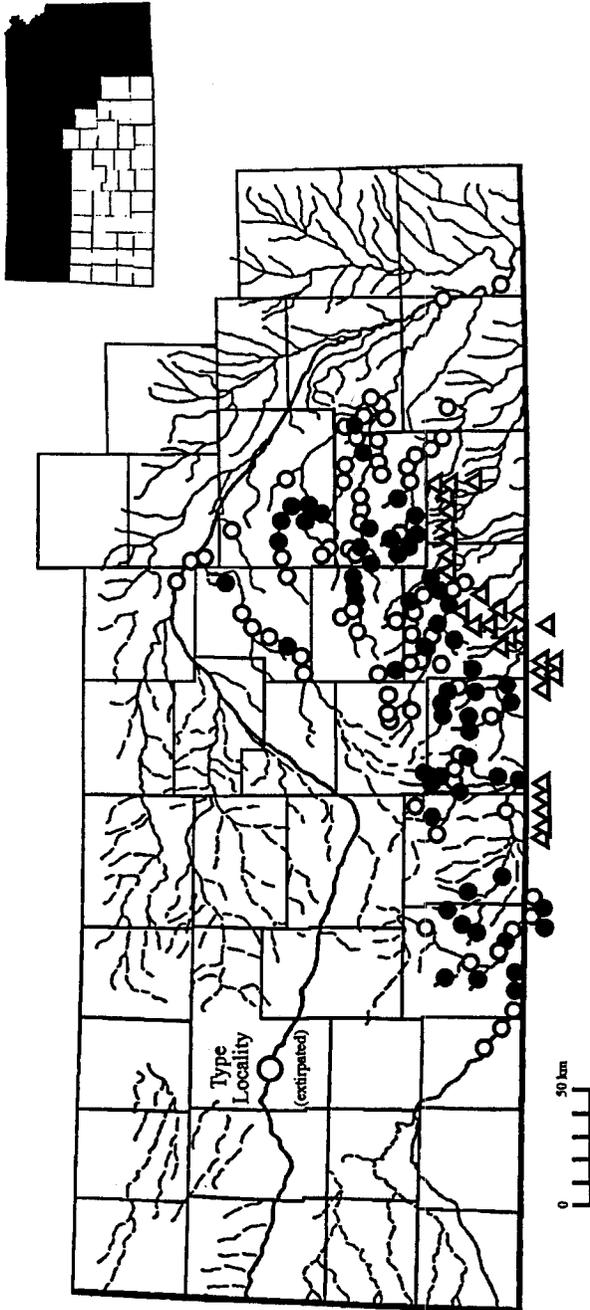


Figure 2. Diagram of the Arkansas darter distribution in the study area in south-central Kansas. Open circles (○) represent historic collection localities. Closed circles (●) are sites where the Arkansas darter was collected during the 1994 through 1997 surveys. Open triangles (△) mark 37 sites sampled during the 1994 through 1997 studies where the Arkansas darter was absent beyond the southern periphery of its known range. Some circles and triangles represent more than one sample location.

RESULTS

The Arkansas darter was recorded from 67 (46%) of the 145 localities sampled from 1994 through 1997 (Fig. 2). Included among these samples, scattered throughout the study area, were 39 stream segments where Arkansas darters had been reported prior to 1994. The Arkansas darter was captured at 26 (67%) of these 39 historic localities. The other 41 (28%) of the 145 sample localities where the Arkansas darter was collected were previously unreported collection sites located within the general historic range of this species. Thirty-seven (25%) of the 145 sites were located outside of the general southern boundary of the historic range of the Arkansas darter (Fig. 2). If we excluded these 37 sample localities outside of its known area of distribution, the Arkansas darter was present at 62% of the sample sites (67 of 108 sites) generally within its historic range. Of the 67 sites where the Arkansas darter was captured, its numbers exceeded 50 individuals at 16 sites (24%). Range contraction due to habitat loss has occurred in the western portion of the study area, generally west of Crooked Creek.

At sites where the Arkansas darter was captured, water temperature varied from 17.0 to 29.3°C. Specific conductance was between 355 and 2700 $\mu\text{S}/\text{cm}$. Canopy cover varied from 0 to 100%, but most localities, including those where the Arkansas darter was absent, had canopy cover estimates of less than 10%. Stream substrates consisted of sand, silt, and organic muck. Submerged, floating-leaved, and emergent macrophytes present at collection sites included *Ceratophyllum*, *Lemna*, *Myriophyllum*, *Nasturtium*, *Potamogeton*, *Sagittaria*, and *Scirpus*.

DISCUSSION

Based on information from the 1994 through 1997 surveys, the Arkansas darter still occurred throughout most of its historic range in south-central Kansas and adjacent Oklahoma (Fig. 2). We also collected it within what had been a large gap in its distribution in the upper Salt Fork Arkansas River Basin. Access to isolated, spring-fed sites in this area of open rangeland is difficult and likely is responsible for the absence of earlier scientific collections. The sites where the Arkansas darter was absent during 1994 through 1997 were outside the known range of this species or the sites lacked suitable habitat. The continued presence of the Arkansas darter at 67% of the 39 historic collection sites and the fact that 28% of the 145 collection localities were previously unreported support the contention that this species is still widespread in this region.

We suggest that the 16 sites where both adult and young Arkansas darters were abundant (more than 50 individuals at each site) represent core populations. These larger populations were present throughout most of the study area. Individuals from core populations might periodically disperse to occupy depopulated or marginal habitats. Arkansas darters also might emigrate to adjacent core populations, thereby

maintaining the larger metapopulation. Given the localized nature of the small spring-fed habitat preferred by the Arkansas darter, we suggest that there are additional core populations that have not been documented.

There are exceptions to all aspects of the description of the spring-fed habitat typically occupied by the Arkansas darter (Moss 1981), which suggest that the species is tolerant of at least short-term variations. During our survey, individuals collected from generally warmer water (greater than 29°C) were predominantly young fish, whereas mixed populations of adult and young darters were captured at groundwater-fed sites with cooler water temperatures (17 to 28°C). We hypothesize that Arkansas darters in the warmer habitat had emigrated from core populations within the stream, perhaps being forced out by population pressures (Taber et al. 1986) or scouring stream flows (Miller 1984).

The Arkansas darter also has been collected in the main stems of the Arkansas and Cimarron rivers (Cross 1967, Matthews and McDaniel 1981, Pigg et al. 1985, Ernsting and Eberle 1989). Its presence in these larger streams might be due, in part, to reduced flows in these rivers that create a habitat similar to the spring-run tributary typically occupied by the Arkansas darter (Cross et al. 1985). Cross et al. (1985) speculated that the Arkansas darter uses rivers as avenues of dispersal from one system of small tributary streams to another. Consistent with this hypothesis, Ernsting and Eberle (1989) reported the presence of four female Arkansas darters in the Arkansas River in central Kansas 25 km upstream from the mouth of Rattlesnake Creek, the nearest known source. This possible 25-km journey by the darters would be in addition to their movement downstream in Rattlesnake Creek, and might have included passage through the salt-marsh area of Quivira National Wildlife Refuge. However, the long distances from one tributary to another along the Arkansas River on the High Plains of western Kansas and eastern Colorado suggest that rivers might be effective dispersal barriers of suboptimal habitat (Miller 1984), especially with the falling water tables and declines in surface flow caused by groundwater mining, diversions of surface water, construction of impoundments, and other factors. Although tributaries with surface water are rare in this portion of the High Plains, Cross et al. (1985) suggested that groundwater seepage formerly maintained pools in low swales connected to the Arkansas River by shallow runs, similar to the "brook" at the type locality for the Arkansas darter (Gilbert 1885). These habitats could have facilitated the dispersal of this species throughout the High Plains portion of the Arkansas River basin. The use of rivers and their larger tributaries by the Arkansas darter for dispersal in south-central Kansas suggested by Cross et al. (1985) seems plausible to us given the relatively high density of small spring-fed streams in this area and the potential vagility of the species (Ernsting and Eberle 1989).

The future of the Arkansas darter is precarious in the extreme western portion of our study area, west of Crooked Creek (Fig. 1). In this region, groundwater is mined extensively from the underlying Ogallala Aquifer (part of the High Plains Aquifer system), primarily for crop irrigation. Of the 420,872 ha in the two counties in this area, 24% (100,366 ha) were available for irrigation in 1984 (Kansas State Board of

Agriculture [1985?]). Water rights in the region have been over-appropriated, and Groundwater Management District #3 follows a policy of controlled depletions (Kansas Water Office 1994). As the water table continues to fall in the area, it causes some formerly perennial streams to become ephemeral, and it eliminates the groundwater seepage that maintains the summer temperature of the surface water at a level appropriate for the Arkansas darter (generally 25°C or less). The largest populations of the Arkansas darter in the western portion of our study area occurred in the main stem of the Cimarron River upstream from Crooked Creek, rather than small spring-fed creeks.

Arkansas darter populations in portions of the Ninnescah River Basin (Fig. 1) also might be at risk due to habitat loss as a result of groundwater withdrawals. This northern basin in our study area overlies the Great Bend Prairie Aquifer, an eastern extension of the High Plains Aquifer. From 1976 through 1984, the amount of land available for irrigation in four counties located in this basin more than doubled, from 29,988 ha to 64,388 ha (Kansas State Board of Agriculture [1977?], [1985?]). Of the 926,213 ha in these four counties, 7% (64,388 ha) was available for irrigation in 1984 (Kansas State Board of Agriculture [1985?]). Groundwater Management District #5, which includes the Ninnescah River Basin, has a policy of safe yield, in which recharge is intended to be approximately equal to withdrawals (Kansas Water Office 1995).

The south-central portion of our study area lies within the rough topography of the physiographic province known as the Red Hills. The topography and the limited groundwater supply with a high mineral content preclude extensive groundwater mining for irrigation in this region, which lies south and east of the more heavily irrigated areas overlying the High Plains Aquifer. Of the 966,359 ha in the four principal counties within this basin, only 0.8% (7,568 ha) was available for irrigation during 1984 (Kansas State Board of Agriculture [1985?]). The actual number of hectares and the relative proportion of hectares available for irrigation in the Red Hills are substantially lower than those in the other two parts of our study area. The potential threat in the south-central region is from local drawdowns of the water table near springs or from other small-scale perturbations, such as pollution from hog farms or other confined livestock operations, that might extirpate specific populations.

There also seems to be a natural constraint on the distribution of the Arkansas darter within the southern portion of the Red Hills in the lower Cimarron, Salt Fork Arkansas, and Medicine Lodge river systems along the Kansas-Oklahoma border (Fig. 2). The absence of the Arkansas darter in this area might be due to the naturally high concentrations of ions in these streams. The Arkansas darter apparently has some tolerance to high chloride levels (as sodium chloride; monovalent ions), based on the presence of a few individuals captured from the lower segment of Rattlesnake Creek (Ernsting and Eberle 1989, Eberle et al. 1996). However, calcium sulfate (divalent ions), leached from abundant gypsum deposits in the Red Hills, is largely responsible for the high conductivities measured in streams draining this region. The ions contributing to the higher conductivities in Rattlesnake Creek and the Red Hills streams (primarily monovalent ions versus divalent ions, respectively) might affect Arkansas

darters differently. Perhaps the Arkansas darter can tolerate the high levels of sodium chloride in Rattlesnake Creek, but not the high levels of calcium sulfate in the southern drainages of the Red Hills; however, this has not been tested. Thus, it is possible that elevated levels of calcium sulfate restrict the distribution of the Arkansas darter to the northern headwater portions of drainages in the Red Hills. Regardless of the contributing ions, we know of no large populations in streams with conductivities greater than 2700 $\mu\text{S}/\text{cm}$.

Given the general distribution of the Arkansas darter in the south-central portion of our study area, we were puzzled by its absence from the headwater reaches of Bluff Creek, a tributary of the Chikaskia River (Fig. 2). Cross (1967) mapped a single collection from the upper Bluff Creek drainage, but the record on which this was based is unknown. We sampled creeks in this drainage that had the cool water and aquatic vegetation typical of Arkansas darter habitat, but the only darter we collected was the orangethroat darter. The reason for the apparent absence of the Arkansas darter in the Bluff Creek drainage is uncertain given that there are records from the upper Chikaskia River and its tributaries; however, it is possible that the Arkansas darter was introduced recently into the Chikaskia River Basin.

The only confirmed records of the Arkansas darter from the upper portion of the Chikaskia River Basin in Kansas are based on unpublished records of collections made from 1978 through 1988. In 1992, Luttrell (1993) extended the known range of this species downstream in the Chikaskia River Basin in Kansas. The existing collection data suggest that the Arkansas darter might have been introduced into the upper Chikaskia River or its tributaries, perhaps from the nearby South Fork Ninnescah River Basin (Fig. 1), and it is now dispersing downstream. This could explain its apparent absence from the Bluff Creek drainage, if one discounts the single report (Cross 1967), because Bluff Creek does not flow into the Chikaskia River until both streams enter Oklahoma (Fig. 1). We are aware of no records of the Arkansas darter in the lower reach of the Chikaskia River from which it could disperse upstream through Bluff Creek (Fig. 2).

The possibility that the Arkansas darter is not native to the Chikaskia River and its tributaries in Kansas is supported circumstantially by differences between the fish communities in the Chikaskia River Basin and the nearby Medicine Lodge, Salt Fork Arkansas, and Ninnescah river basins. The Medicine Lodge and Chikaskia rivers are both tributaries of the Salt Fork Arkansas River, with confluences in Oklahoma (Fig. 1). The Ninnescah River is a tributary of the Arkansas River, and it is located entirely within Kansas (Fig. 1). The native fauna of the Medicine Lodge, Salt Fork Arkansas, and Ninnescah river basins includes (or included) peppered chub (*Macrhybopsis tetranema*; Eisenhour 1999), Arkansas River shiner (*Notropis girardi*), and plains minnow (*Hybognathus placitus*), which apparently were absent from the Chikaskia River Basin in Kansas (Moore and Buck 1953, Cross 1967). These three species of minnows, particularly the plains minnow, sometimes moved into the lower Chikaskia River from the Salt Fork Arkansas River in Oklahoma (Moore and Buck 1953). Based on their likely distributions in south-central Kansas prior to 1850, there seems to be an

intuitive correlation between the presence of these three species of minnows in the warm, open water of the river main stems and the occurrence of the Arkansas darter in the cool, vegetated tributaries. All four species apparently were native to the Medicine Lodge, Salt Fork Arkansas, and Ninnescah river basins, and all four, except for the previously mentioned records of the Arkansas darter, were absent from the Chikaskia River Basin in Kansas (Cross 1967).

Alternatively, the presence of the Arkansas darter in only the upper portion of the Chikaskia River Basin might be indicative of the general southern limit to its range (Fig. 2). The relatively recent range extensions in the Chikaskia River Basin might reflect changes in stream habitats similar to those in the upper Cimarron River that have allowed the Arkansas darter to more readily move into the main stem of the river (Cross et al. 1985, Pigg et al. 1985). The relatively isolated population in Bluff Creek might now be extirpated, or we might have failed to capture individuals from a sparsely populated stream reach. The missing elements from the local ichthyofauna in the upper portion of the Chikaskia River Basin also might be an artifact of limited faunal surveys, as summarized by Cross (1967) and Moore and Buck (1953). Additional surveys in the Chikaskia River Basin to monitor the distribution and potential dispersal of the Arkansas darter in this drainage might help to answer this question. A thorough study of water quality attributes, including quantitative data on the various ions, in streams throughout our study area also would be useful.

The overall condition of Arkansas darter populations in south-central Kansas seems to be reasonably stable, but threats remain. As land-use patterns continue to change in this region, steps to regularly monitor the status of the Arkansas darter should be implemented. The area of greatest concern is in the Ninnescah River Basin, where large-scale groundwater declines are possible. If these declines occur, the result is likely to be similar to the situation in the western portion of our study area, where the Arkansas darter is on the verge of regional extirpation. Groundwater appropriations for agricultural, industrial, or municipal use in Ninnescah River Basin should be monitored by appropriate wildlife agencies so that they can be in a position to take effective preventive actions. Less dramatic, but equally important, is the possibility that local extirpations could occur throughout the range of the Arkansas darter. In this event, we currently have no knowledge of the genetic attributes of the various populations. Yet this information is essential to the proper management of the Arkansas darter and could be used to protect unique genetic components of the species and to determine appropriate sources of individuals used to replace extirpated populations.

ACKNOWLEDGMENTS

Our project was funded through the Kansas Department of Wildlife and Parks with money provided by the United States Fish and Wildlife Service (Section 6 of the Endangered Species Act). We were assisted by Tom Flowers (Natural Resource Conservation Service, Meade, Kansas), Ken Brunson (Kansas Department of Wildlife

and Parks, Pratt, Kansas), Kevin Williams (Rockhurst College, Kansas City, Missouri), and David Coffey and Chad Stinson (Southeast Oklahoma State University, Durant, Oklahoma). Tim Patton and an anonymous reviewer contributed greatly to the final version of the manuscript. Data from stream surveys conducted throughout western Kansas from 1994 through 1997 by the Environmental Services Section of the Kansas Department of Wildlife and Parks, Pratt, Kansas, and the Sternberg Museum of Natural History at Fort Hays State University, Hays, Kansas, were used in our assessment.

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Received: 4 February 2000

Accepted: 21 December 2000