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The Ouachita darter (*Percina* sp. nov.), a morphologically distinct form of the longnose darter (*Percina nasuta*), is endemic to the Ouachita River drainage and is considered an undescribed species (Robison and Buchanan, 1988; Robison, 1992). Most records of occurrence are from the upper Ouachita River within the boundary of the Ouachita National Forest. The U.S. Forest Service considers the Ouachita darter a sensitive species and Robison and Buchanan (1988) considered it a species of special concern. Historically, the Ouachita darter has been captured in low numbers, and there is limited ecological information available on habitat preferences or abundance. Since the darter occurs in low numbers within a relatively large river, it is difficult to capture and estimate abundance with confidence. The objectives of this study were to develop a methodology for estimating population levels of the darter and define the preferred habitat of the Ouachita darter based on water depth, velocity, and substrate composition.

In the late spring of 2000, a preliminary survey of 35 sites on a 9.6-km section of the Ouachita River between Pine Ridge and Shirley Creek campground, Montgomery County, AR indicated certain habitat characteristics associated with the Ouachita darter (Table 1). We used this preliminary data to identify reaches of likely habitat in an effort to concentrate our sampling as we continued downstream in the following year. During the summer of 2001, we sampled a 6.5 km section of the Ouachita River between Shirley Creek campground and the bridge at Arkansas Highway 379.

This section of the river was floated in a canoe to classify each macrohabitat type as run, riffle, or pool in mid-May, 2001. Locations and lengths of each habitat were determined with a Trimble Geo Explorer (GPS) and widths were measured with a Bushnell Yardage Pro 400 range finder. We measured water temperature, dissolved oxygen, nitrate, conductivity, turbidity and pH by towing a Hydrolab Datasonde 4 behind the canoe.

Based on our preliminary survey, we identified preferred habitat as reaches with emergent, semi-aquatic macrophytes growing along the edge of runs (primarily water willow, *Justicia* sp.). These reaches and adjacent habitat immediately upstream and downstream were sampled by snorkeling on the last week of July and the first week of August. Three snorkelers started at the downstream

Table 1. Habitat type and water quality at sites with Ouachita darters in the preliminary survey of the Ouachita River between Pine Ridge and Shirley Creek in 2000.

Habitat type[a]	pH	Conductivity (µS)	Velocity (m/s)	Ouachita darters observed[b]
Run	7.3	44.5	0.38	3
Run	7.2	67.6	1.25	6
Riffle	7.2	71.0	0.42	5
Riffle	7.2	72.2	0.75	+2
Mean =	7.2	63.8	0.70	Total=16

[a] Most sites with Ouachita darters also had clean gravel substrate.
[b]Over thirty other sites were also surveyed but Ouachita darters were not found.

ends of these reaches and proceeded upstream for 20 minutes while counting Ouachita darters (providing one person-hour of effort). Basin Area Stream Survey methodology was followed to characterize the physical variables along a transect in the center of each macrohabitat (Clingenpeel and Cochran, 1992). We also characterized microhabitat at the point where the density of Ouachita darters was the highest in a particular site. Variables included water depth, water velocity at the standard 6/10 total depth and at maximum depth (close to where darters live), and a visual estimate of substrate composition.

When Ouachita darters were observed, we used a seine (3.0 m x 1.8 m with 5-mm mesh) and a Smith-Root Model 12 backpack electrofisher to capture them. The two approaches were used singly and in combination to maximize capture. We also returned to site 4, a reach of high Ouachita darter density based on the initial snorkel survey, to conduct a mark/re-sight population estimate. Fish were captured by a "herding" technique that involved a snorkel and a set-seine. Two individuals held a seine perpendicular to the current and the seine was tilted back until it was lying flat on the substrate. The lead-line of the seine was buried in the substrate to restrict darters from escaping under it. A third individual, 4 to 5 m upstream, located a Ouachita darter by snorkeling and then gradually directed the fish into the seine. The seine was quickly raised once the darter

Table 2. Means and standard deviations of water quality variables in the Ouachita River between Shirley Creek and AR Hwy 379 in May, 2001 (n=24).

	Mean	Standard deviation
pH	7.6	0.2
Conductivity (µS)	67	0.4
Temperature (°C)	26	0.5
Turbidity (NTU)	5.6	0.4
Nitrate (mg/L)	0.32	0.05
Dissolved Oxygen (mg/L)	8.6	0.4

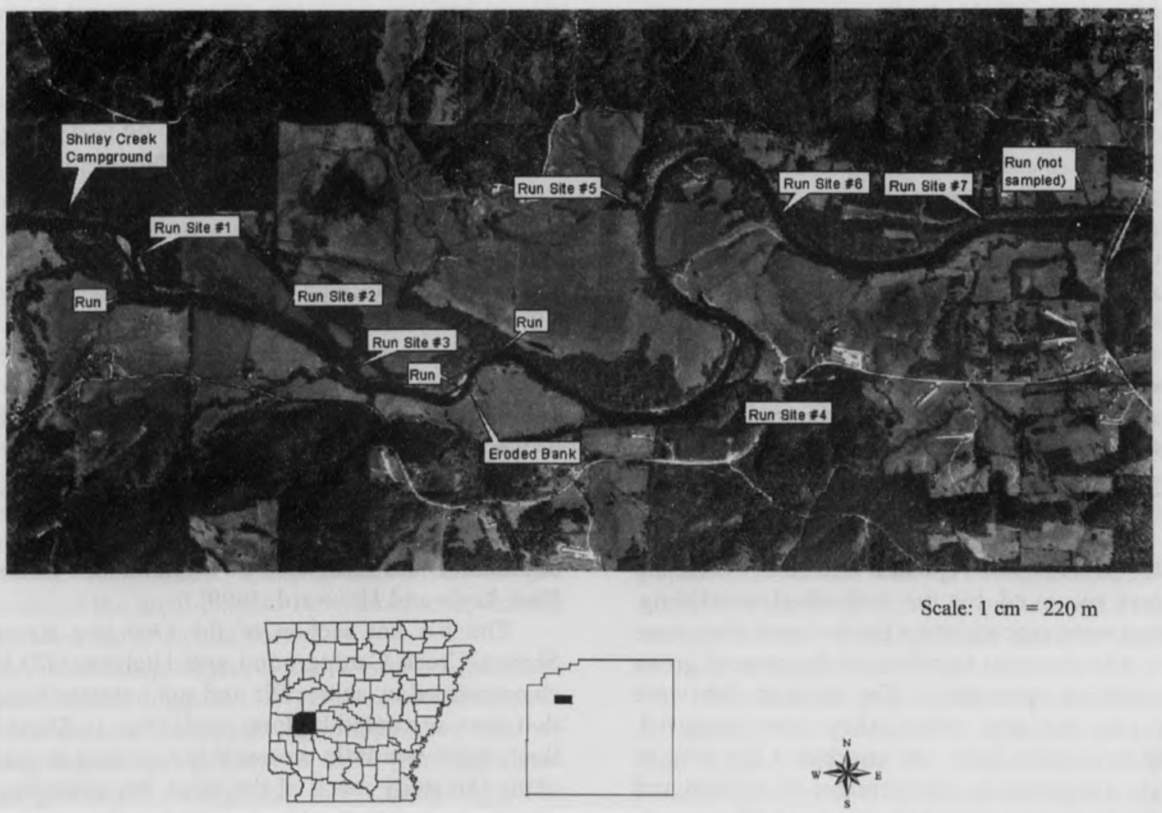

Fig. 1. Macrohabitat types and sites where Ouachita darters were found in the Ouachita River between Shirley Creek and AR Hwy 379. All riffles and runs were snorkeled except the farthest downstream and Ouachita darters were found in all that are identified by site numbers.

231

Table 3. Numbers of Ouachita darters observed during one person-hour of snorkeling and associated habitats at seven sites on the Ouachita River between Shirley Creek and AR Hwy. 379 in the summer of 2001. Microhabitat was from the point of highest darter density in each site. Because depth and velocity were typically zero at both banks along macrohabitat transects, we presented the means of these variables with and without the data from the banks (standard deviations in parentheses). Column totals or means with standard deviations in parentheses are also shown.

			Microhabitat at a point				Macrohabitat with banks				Macrohabitat without banks		
Site	Sample area (m^2)	Ouachita darters observed	Percent cobble	Depth (cm)	Velocity @ 6/10 depth	Velocity @ max depth	Percent cobble	Depth (cm)	Velocity @6/10 depth	Velocity @ max depth	Depth (cm)	Velocity @ 6/10 depth	Velocity @ max depth
1	80	18	60	26	0.30	0.12	40	14	0.19	0.08	22	0.32	0.13
								(11.7)	(0.21)	(0.09)	(4.2)	(0.16)	(0.06)
2	60	2[a]	50	16	0.37	0.21	40	35	0.10	0.06	58	0.17	0.11
								(43.0)	(0.09)	(0.05)	(41.8)	(0.04)	(0.02)
3	54	8	50	23	0.32	0.15	30	13	0.16	0.08	21	0.26	0.14
								(11.9)	(0.15)	(0.08)	(5.0)	(0.06)	(0.02)
4[b]	28	9	70	26	0.20	0.12	50	22	0.11	0.06	37	0.18	0.10
								(20.5)	(0.11)	(0.06)	(8.2)	(0.07)	(0.04)
5	64	12	70	21	0.34	0.18	50	17	0.14	0.07	28	0.23	0.12
								(14.9)	(0.13)	(0.06)	(4.1)	(0.05)	(0.01)
6	72	18	60	23	0.20	0.11	50	18	0.14	0.07	30	0.23	0.12
								(15.9)	(0.14)	(0.06)	(6.5)	(0.09)	(0.02)
7[c]	+ 28	+ 7	-	-	-	-	-	-	-	-	-	-	-
	386	74	60	22.5	0.29	0.15	43	19.8	0.14	0.07	32.6	0.23	0.12
			(8.9)	(3.7)	(0.10)	(0.04)	(8.2)	(8.08)	(0.03)	(0.01)	(13.7)	(0.05)	(0.02)

[a] Based on two person-hours of sampling.
[b] This site was selected for a mark/re-sight, population estimate resulting in an estimate of 32 darters (90% C.I. = 13 to 51).
[c] Physical habitat was not measured at site 7 but visual observations were consistent with other sites.

was inside. This process was repeated until there were no Ouachita darters observed by the individual snorkeling. Captured darters were placed into a bucket until they were marked with a subcutaneous injection of fluorescent green dye in the suborbital epidermis. The marked fish were released back into the area where they were captured. Approximately two hours later, we snorkeled the area to search for marked individuals. The number of marked and unmarked individuals was recorded. We used Chapman's modification of the Peterson method to estimate population abundance and associated 90% confidence limits (e.g. Van Den Avyle and Hayward, 1999).

The 6.5 km section of the Ouachita River between Shirley Creek Campground and Highway 379 bridge was characterized by short riffle and run habitats (total of 870 m) that were separated by long pools (Fig. 1). During the 2001 float, there was little measurable variation in water quality along the study reach of the river. For example, the mean nitrate concentration was 0.32 mg/L with a standard deviation of only 0.05 mg/L (Table 2). We identified four vegetated runs that were characteristic of the habitat that held Ouachita darters in the spring of 2000. During our snorkeling surveys, no Ouachita darters were found in these reaches. However, Ouachita darters were present in transition zones between riffles and runs.

A total of 74 Ouachita darters as observed at seven of the ten run sites within the study area (Fig. 1 and Table 3). The number of Ouachita darters per site (for sites where the darters were observed) ranged from 2 to 18 versus a range of 2 to 6 for the 2000 study in the reach immediately upstream. Microhabitats usually consisted of the upstream end of a run with slight surface agitation due to the adjacent riffle. The mean depth and velocity at maximum depth of the microhabitat was 22 cm and 0.15 m/s, respectively. Microhabitats contained a higher percentage of cobble than the transect line at the middle of the predicted macrohabitat (Table 3). The mean substrate composition of microhabitats with Ouachita darters was 60% cobble and 40% gravel versus 43% cobble and 47% gravel for the associated runs.

Ouachita darters used the cobble substrate for cover when approached. Consequently, continuous slow snorkeling was less effective than intermittent snorkeling (moving to the edge of visibility, then waiting 20-30 seconds for the darters to emerge from cover before moving again). Seining where the darters were observed, resulted in only one darter captured after 16 attempts (2.5 person hours). Similarly, we only captured two darters with the use of electricity (8 person hours). Herding the darters while snorkeling resulted in 10 captures in 3 person hours of sampling. We successfully marked and released 8 Ouachita darters and counted 10 during the re-sight attempt. Only 2 of these were marked, thus we estimated the population for the 28 m^2 area to be 32 with 90% confidence limits of 13 to 51. The mean length of the thirteen captured darters was 50 mm and ranged from 43 to 54 mm.

The Ouachita darter occupied a similar microhabitat at each site and was rarely seen outside of this microhabitat. The darters preferred upstream edges of runs in late summer when the water level was low (discharge was around 1.4 m^3/s). Records from 1942 to 2000 at the nearby Mount Ida gauging station show that discharge exceeds 0.9 m^3/s 90% of the time and exceeds 7.0 m^3/s 50% of the time (USGS, 2001). Low water level, characteristic of late summer, reduces the areal extent of preferred microhabitat and concentrates the Ouachita darters.

The microhabitat preference that we found, contrasts with the pool habitat suggested by Robison and Buchanan (1988) for late summer habitat. It also differs from what we found during higher spring flows in 2000 (two significant rain events occurred during the 2000 sampling). The discrepancy is most likely due to temporal variations in the availability of preferred habitat. We found the darters in microhabitats that invariably included slight surface agitation and a high percentage of cobble substrate.

Substrate size and arrangement are among the most important microhabitat features for several darter species (Hlohowskyj and Wissing, 1986). The cobble habitat, where the darters were concentrated, was free from the sedimentation that was common in nearby habitats without Ouachita darters. This absence of sediment provided interstitial spaces, which the Ouachita darters frequented for cover. This common response of Ouachita darters was rare among the other seven species of darters observed. It seems that clean cobble substrate may constitute a critical summer habitat for this species. The clean gravel substrates that were typical of where Ouachita darters were found in the previous spring were abundant at that time of year.

Excessive sedimentation resulting from careless land-use practices may significantly reduce availability and suitability of clean cobble substrate (Danielson, 1991). Berkman and Rabeni (1987) found that sedimentation from bank and channel erosion was pervasive in Ozark streams, and it altered densities of benthic, riffle-inhabiting, insectivorous and herbivorous fishes. Riffles and runs adjacent to and immediately downstream of the eroded bank observed in this study (Fig. 1) contained a high degree of sedimentation. These riffles and runs had few darters that were common elsewhere in the river and no Ouachita darters. A similar pattern was observed in the 2000 study. Low water levels can also reduce the extent of preferred habitat if velocity becomes too low to keep the substrate clean. Lobb and Orth (1991) found riffle and run habitats to be the most sensitive to reductions in flow.

Structure, such as course substrate, within a habitat can also reduce capture efficiency (Parsley et al., 1989). The substrate and the evasive behavior of the Ouachita darter may explain the low capture efficiency of seines and backpack electrofishers. Both techniques resulted in Ouachita darters hiding in interstitial spaces or swimming away from captors more than other darter species. Consequently, the herding technique was the most efficient way to capture this species. Once the preferred habitat was identified, we were able to capture 10 darters in an hour (3 person hours). Our approach met the assumptions of the Peterson method. However, the lower limit of the population estimate was 13, which was less than the known number of darters present (8 marked and 8 unmarked). This artifact resulted from a small sample size and the low number of recaptures.

The estimated population of 32 Ouachita darters in 28 m^2 should be considered an upper range of density rather than typical, because the darters were concentrated into small areas of preferred habitat during the late summer and we selected a site with high density to maximize our chances of estimating a confidence interval. Extrapolation to estimate darter abundance for the entire 6.5 km study reach

Journal of the Arkansas Academy of Science, Vol. 56 [2002], Art. 34

involves a significant assumption. We only observed 9 Ouachita darters in our initial snorkel survey of site 4, yet our population estimate was 32. If one assumes that our sight success was similar for the 74 fish observed at other sites, then the entire reach probably had about 260 Ouachita darters. That abundance constitutes an extremely low darter density for a 6.5 km reach of river. However, only 870 m (13.3%) of the river was riffle or run habitat. When one considers that the identified microhabitat was less than a quarter of the riffle and run macrohabitat, it seems that densities of this species in its preferred habitat were low, but not extremely low, compared to other darter species.

Kessler and Thorp (1993) found that microhabitat studies provide basic ecological information needed for management plans. In the case of the Ouachita darter, microhabitat analysis helped explain sampling difficulties and indicated vulnerability to sedimentation and low streamflow. We conclude that late summer is the most efficient season to sample the Ouachita darter and that a multi-scale approach is needed.

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