JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE 83(3–4):52–56 JULY–OCTOBER 2008

DISTRIBUTION OF THE THREATENED SNAIL DARTER (*PERCINA TANASI*) IN THE UPPER TENNESSEE RIVER DRAINAGE

MATTHEW J. ASHTON AND JAMES B. LAYZER

Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, P. O. Box 5114, Cookeville, TN 38501 (MJA)

Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, Tawes State Office Building, C-2, Annapolis, MD 21401 (present address MJA)

US Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, P. O. Box 5114, Cookeville, TN 38501 (JBL)

ABSTRACT—Discovered in 1973, the snail darter (*Percina tanasi* Etnier) was extirpated from the Little Tennessee River upon completion of Tellico Dam in 1979. Originally listed as a federally endangered species in 1975, the snail darter was transplanted to several other rivers. In 1983, the snail darter was relisted as threatened after individuals were collected in five streams. By 1993, additional individuals had been collected in nine tributaries of the Tennessee River in Alabama, Georgia, and Tennessee. From May to October 2005, we sampled these nine streams to determine the species's present distribution. In each stream, we sampled by backpack electrofishing using a standard unit-of-effort (28 m^2). When visibility permitted, we also snorkeled to locate snail darters. We collected 154 snail darters by electrofishing from seven streams and observed 230 snail darters while snorkeling. The largest populations of snail darters were found in the French Broad and Hiwassee rivers. Our collections in those rivers included young-of-year and individuals up to four years old. Relatively few individuals were collected in Big Sewee and South Chickamauga creeks, and the Holston, Little, and Sequatchie rivers. No snail darters were encountered in the Paint Rock River, Alabama, and Ocoee River, Tennessee.

The snail darter, *Percina tanasi* (Etnier), was discovered in 1973 in the Little Tennessee River, Tennessee, and at that time no other populations were known (Etnier, 1976). The species was subsequently listed as endangered in 1975. Between 1975 and 1980, recovery efforts included transplanting *P. tanasi* into the Hiwassee, Holston, Nolichucky, and Elk rivers in Tennessee. The species was reclassified as threatened in 1983 after recovery efforts established a reproducing population in the Hiwassee River and additional specimens were collected in the Paint Rock River, Alabama, the Sequatchie River, and Big Sewee and South Chickamauga creeks, Tennessee (Biggins and Eager, 1983).

A member of the subgenus *Imostoma*, *P. tanasi* is endemic to the upper Tennessee River basin in Alabama, Georgia, and Tennessee (Etnier, 1976). Historically, this species may have inhabited the main channel and lower reaches of major tributaries of the Tennessee River from the northward bend in Alabama upstream. Clean gravel shoals were thought to define its distribution in the Little Tennessee River (Starnes, 1977). *Imostoma* darters typically live for three years and occasionally into a fourth year (Etnier and Starnes, 1993). Additional life history characteristics include a diet dominated by snails, an early spawning period (February–April), and downstream drift of pelagic, phototaxic larvae (Robinson and Buchanan, 1988; Etnier and Starnes, 1993; Haag and Warren, 2006). Starnes (1977) hypothesized that larval *P. tanasi* were pelagic for 15 to 20 days and transported considerable distances downstream from shoals inhabited by adults. Young-of-year (YOY) returned upstream to shoals in the Little Tennessee River beginning in June and were abundant by August of their first year (Starnes, 1977).

The distribution of *P. tanasi* populations has changed since the species was downlisted to threatened. Since 1983, *P. tanasi* have been collected in four additional streams in Tennessee (French Broad, Little, Holston, and Ocoee rivers) (Etnier and Starnes, 1993; Scott et al., 1996). Individuals were first collected in the French Broad River in 1988, though none had been found as a result of rotenone surveys just a few years earlier (Harned, 1979; Tomljanovich and Saylor, 1989). This population of *P. tanasi* is thought to have resulted from the transplantation into the Holston River in 1979 (Etnier and Starnes, 1993). The effort was originally considered a failure (Biggins and Eager, 1983); however, a single specimen was collected in 1989 (Yeager and Tomljanovich, 1990). Since 1983, few *P. tanasi* have been collected in the Paint Rock River, Alabama, the Sequatchie River, and Big Sewee and South Chickamauga creeks, Tennessee (TVA Natural Heritage Data, 2006). Thus, while new populations have been discovered since 1983, others may have been lost or their status is unknown. The objectives of our study were to determine the current distribution and status of known *P. tanasi* populations.

METHODS

The study area included nine tributaries (French Broad, Hiwassee, Holston, Little, Ocoee, Paint Rock, and Sequatchie rivers, and Big Sewee and South Chickamauga creeks) of the upper Tennessee River in Alabama, Georgia, and Tennessee,

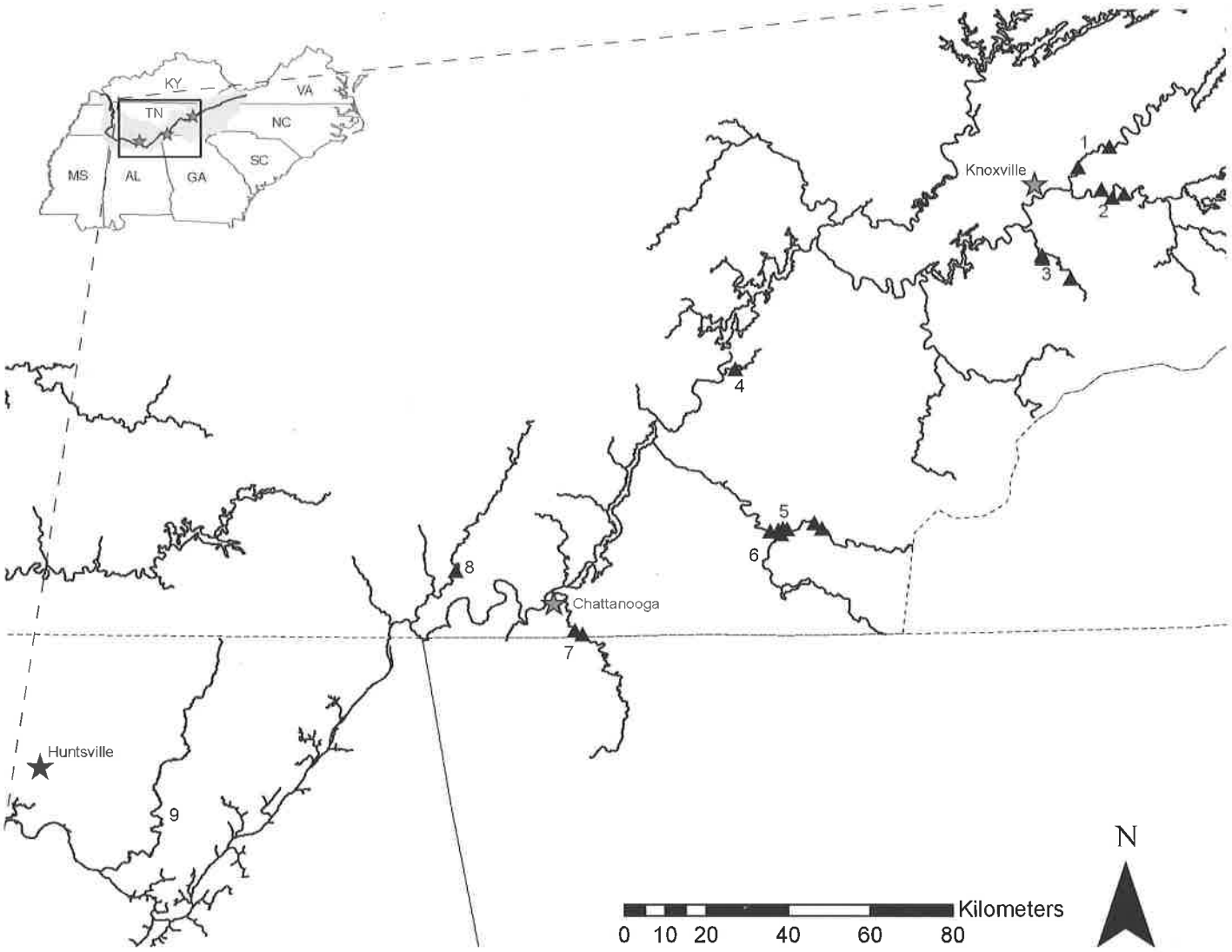

FIG. 1. Study area of streams surveyed for *Percina tanasi* in 2005 (1 = Holston River; 2 = French Broad River; 3 = Little River; 4 = Big Sewee Creek; 5 = Hiwassee River; 6 = Ocoee River; 7 = South Chickamauga Creek; 8 = Sequatchie River; 9 = Paint Rock River). Black triangles represent locations where specimens of *P. tanasi* were collected by electrofishing or observed by snorkeling.

where *P. tanasi* were previously collected (Fig. 1). The Elk and Nolichucky rivers in Tennessee were not sampled because transplantations apparently failed (Etnier and Starnes, 1993). The population of *P. tanasi* in the Little Tennessee River was lost upon completion of the Tellico Dam and its subsequent inundation of the river (Biggins and Eager, 1983).

We sampled from May to October 2005 during low-flow conditions to determine within-stream distribution and relative abundance of *P. tanasi*. We used catch-per-unit-effort (CPUE) as a measure of relative abundance. Within-stream distribution was calculated as the distance between the furthest upstream and downstream sites where we collected *P. tanasi*. We sampled accessible sites where individuals of *P. tanasi* were previously collected and other shoals containing suitable habitat. Sampling began at the most downstream accessible shoal in each stream and continued upstream until no specimens of *P. tanasi* were collected at $\geq$ 2 shoals. Physical barriers, such as a dam or a waterfall, served as an ending point of sampling in the Little and Sequatchie rivers, and in Big Sewee and South Chickamauga creeks. Our sampling protocol followed that of Scott (2003) for monitoring *P. tanasi* in the French Broad River. Fish were collected with a backpack electrofishing unit with a stationary seine (4.6 by 1.2 m, 0.64 cm mesh) located approximately 6.1 m downstream. One unit-of-effort consisted of thoroughly electrofishing this approximately 28-m^2 area. Typically, a sampling crew consisted of four people: two seine holders, an electrofishing operator, and one person either kicking into the seine or assisting with the seine in strong flow. Total length (TL) of all individuals collected was measured to the nearest millimeter. Age-classes were determined from length frequency histograms and compared to age-class designations by Eager (1982) and Scott (2003). Sex was determined for individuals $\geq$ 50 mm TL. All specimens were released immediately after measurement. We used a Garmin hand-held GPS unit to determine latitude and longitude (WGS84 datum) of sites where *P. tanasi* were collected and TerraServer topographic maps if they were not collected.

TABLE 1. Total number of electrofishing samples, catch-per-unit-effort (CPUE) of *Percina tanasi* collected by electrofishing, and number of observations made while snorkeling during 2005.

Stream	Number of *Percina tanasi*		Number of samples	CPUE	Length range (mm)
	Collected	Observed			
French Broad River	113	210	335	0.34	39–87
Hiwassee River	24	18	260	0.09	46–84
Holston River	5	0	195	0.03	62–77
Little River	4	2	390	0.01	60–80
Ocoee River	0	0	45	0.00	—
Paint Rock River	0	—	96	0.00	—
Sequatchie River	1	0	118	0.01	70
Big Sewee Creek	2	—	74	0.03	58–59
South Chickamauga Creek	5	—	441	0.01	56–79
Total	154	230	1954	—	—

If we did not collect any *P. tanasi* by electrofishing at a site and if stream conditions permitted, we snorkeled for 1.5–4 person hours to verify their absence. Snorkelers began at the downstream end of the site and slowly proceeded upstream in a random direction to observe as much area as possible. At larger or longer shoals, snorkelers first floated downstream through the area and then began snorkeling back upstream when they reached the lower end of the shoal. We also snorkeled for approximately 4–6 person hours at several sites with expansive shoals in the French Broad River.

RESULTS

We sampled 77 sites by electrofishing and collected *P. tanasi* in 7 streams (Table 1). We took a total of 1,954 samples (units-of-effort) and collected 154 individuals. *P. tanasi* were most abundant in the French Broad River where we collected 113 individuals. We collected 24 *P. tanasi* in the Hiwassee River but ≤ 5 individuals in each of the following: Holston, Little, and Sequatchie rivers and Big Sewee and South Chickamauga creeks. We did not collect any *P. tanasi* in the Ocoee or Paint Rock rivers. We typically made 26.7 ± 4.3 (mean ± *SE*) samples at a site though we varied effort in relation to the size of a site and available habitat. Catch-per-unit-effort was greatest in the French Broad River (0.34) while in the remaining streams we sampled, CPUE was ≤ 0.09 (Table 1).

Throughout 2005, we observed a total of 210 *P. tanasi* while snorkeling at Rkm 12.9 in the French Broad River (Table 1). Although visibility was suitable (≥ 2 m), we did not see any *P. tanasi* at other sites in the French Broad River nor in the Holston River, including sites where we had previously collected them by electrofishing. We did not snorkel in the Hiwassee River because the typical flow regime dictated that we sample only between 0700 and 1300 h; overhead light was poor early in the day and insufficient time remained to snorkel before discharge from the upstream dam created unsafe conditions. However, we did observe a total of 18 *P. tanasi* in the Hiwassee River while wading at our sample sites on 10 September, 24 September, and 23 October 2005. Visibility in the Little River was generally poor (< 1 m) and limited snorkeling opportunities at most sites; however, we did see 2 *P. tanasi* at Rkm 33.0 after we failed to collect any by electrofishing. Visibility varied widely among the remaining streams and we did not see any *P. tanasi* during the limited snorkeling opportunities.

Percina tanasi distribution varied among the 9 streams sampled (Table 2). We found their distribution increased slightly in the Holston River (0.3 km). While the upstream extent of *P. tanasi* distribution increased in the Little River, their overall distribution within the stream slightly decreased. We found that *P. tanasi* expanded their upstream distribution by 10.3 km in the Hiwassee River. We were unable to access the lower 7 km of river where *P. tanasi* were previously collected; therefore, we cannot determine the lower extent of their distribution. In the remaining streams we sampled, within-stream distribution of *P. tanasi* decreased (range: 4–23.5 km) from the greatest previously reported distributions.

On 18 May 2005, we sampled the French Broad River at Rkm 12.9 with TVA personnel and collected 69 individuals. Lengths from an additional 48 specimens collected by another crew sampling at the same site that day are included in the length-frequency histogram (Fig. 2). Examination of the length-frequency distribution indicates that 4 age groups (I–IV+) were collected. In early August, we collected young-of-year (YOY) *P. tanasi* by electrofishing at Rkm 12.9. The Hiwassee River was the only other stream where we collected > 2 age groups of *P. tanasi*.

DISCUSSION

We collected *P. tanasi* in 7 of the 9 streams from which the species has been previously reported. Based on the numbers of *P. tanasi* collected or observed, the most robust populations reside in the French Broad and Hiwassee rivers. In both rivers, we collected 5 age groups (YOY–IV+) of *P. tanasi*. In the remaining streams, ≤ 2 age groups composed of older individuals were present. Starnes (1977) found that the majority of *P. tanasi* in the Little Tennessee River population were one year old. Similarly, we collected few individuals > I+, which suggests high mortality of older fish. Although the length of stream occupied in the Hiwassee River was greater than the length occupied in the French Broad River, CPUE was greater in the latter river. Moreover, shoals in the French

TABLE 2. Number of sampling sites, stream reach sampled, and stream reach occupied (most downstream and upstream site) by *Percina tanasi* in study area. Previously reported distributions are based on Eager, 1982; Biggins and Eager, 1983; Scott et al., 1996; Scott, 2003; TVA Natural Heritage Database, 2006; A.K. Wales (pers. comm.).

Stream	Number of sites sampled	Reach of stream (Rkm)		
		Sampled	Presently occupied	Previously reported distribution
French Broad River	6	12.9–48.0	12.9–24.5	12.9–48.0
Hiwassee River	12	53.1–72.7	53.1–71.5	46.7–61.2
Holston River	5	8.0–41.0	8.0–23.5	8.0–23.2
Little River	17	13.5–35.2	14.5–33.0	12.9–32.5
Ocoee River	2	4.7–9.5	—	9.5
Paint Rock River	7	25.6–40.2	—	25.6–39.6
Sequatchie River	7	12.9–27.4	27.4	11.4–27.4
Big Sewee Creek	3	5.6–9.2	6.8	5.1–9.2
South Chickamauga Creek	18	13.2–31.1	21.2–25.7	9.5–31.1

Broad River were two to four times longer and wider than shoals in the Hiwassee River.

The abundance of *P. tanasi* in the French Broad River has increased substantially since the species was first collected in 1988. Although we did not collect any *P. tanasi* at Rkm 48.0, just 1 *P. tanasi* has ever been collected at that site on the French Broad River (Scott, 2003). Thus, the species's distribution seems to have remained relatively stable over time with the population centered at Rkm 12.9. This site is the first major shoal in the river upstream from the backwater of Ft. Loudoun Reservoir. Upstream of Rkm 12.9, extensive gravel shoals exist, but they are dominated by macrophytes, and they experience rapid and extreme fluctuations in flow due to peaking hydroelectric discharge from Douglas Dam. The distribution of *P. tanasi* in the Hiwassee River has expanded considerably since they were translocated in 1975. While we collected relatively few *P. tanasi* in the Hiwassee River, we suspect this was not representative of the true population size. Rather, their consistent occurrence over a long reach highlights the difficulty in sampling for *P. tanasi*. In addition to

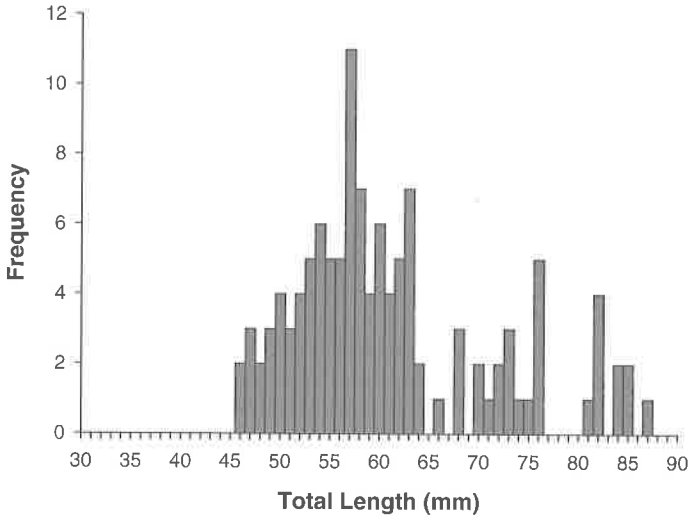

FIG. 2. Length-frequency distribution of *Percina tanasi* ($n = 117$) collected from Rkm 12.9 of the French Broad River, Tennessee, 18 May 2005.

individuals we observed while wading in 2005, we observed more *P. tanasi* at the same sites while snorkeling in 2006 (Ashton and Layzer, unpublished data).

Often, it is difficult to document the complete distribution of a rare species because sampling effort may be insufficient to detect them at extremely low densities. In particular, it is difficult to determine the current status of *P. tanasi* populations in the Holston, Little, and Sequatchie rivers, and in Big Sewee and South Chickamauga creeks, because we collected ≤ 5 *P. tanasi* in each. Furthermore, sampling dates, frequency, and methods have varied considerably among collectors making it difficult to compare data. Variability among years in numbers and distribution of *P. tanasi* collected in these streams could reflect either sampling efficiency or variations in year class strength. For example, the abundance of *P. tanasi* at the lowermost shoal in the Holston River (Rkm 8.0) has varied since 2000, while it has remained relatively stable at Rkm 26.2 (Scott, TVA, unpublished data). Nonetheless, the numbers of *P. tanasi* we collected and those historically collected suggest that populations in Holston, Little, and Sequatchie rivers, and in Big Sewee and South Chickamauga creeks are small. Alternatively, some of these streams may not support reproducing populations. Instead, *P. tanasi* in some of these streams may have originated from more robust populations in either the French Broad or Hiwassee rivers. Newly hatched larval *P. tanasi* could drift from the French Broad River to the mouth of the Little River in < 3 days (Scott, TVA, unpublished data). The potential for dispersal is further highlighted by the discovery in 2007 of an individual in Citico Creek, a tributary to the Little Tennessee River (Rakes, CFI, pers. comm.). *Percina tanasi* were extirpated from the Little Tennessee River upon closure of Tellico Dam (Biggins and Eager, 1983; Etnier and Starnes, 1993). Consequently, the individual found in Citico Creek must have hatched in another stream and dispersed. The current status of *P. tanasi* in the Paint Rock River is unknown because we did not collect any and only 7 individuals have been collected in the past 24 years (TVA Natural Heritage Data, 2006). If a population persists in the Paint Rock River, it must be very small. A reproducing population of *P. tanasi* probably never occurred in the Ocoee River since the only individual ever collected was found just upstream of the

confluence with the Hiwassee River. Undoubtedly, that fish moved into the Ocoee River from the Hiwassee River.

Habitat quality may limit *P. tanasi* abundance and distribution. Silt, the primary stream pollutant (US EPA, 1994), affects benthic stream fishes by degrading spawning habitat and food availability (Waters, 1995). At many sites we sampled where riparian vegetation was limited, aquatic macrophytes or silt covered the substrate. Most sites we sampled in the Little River were affected by siltation and lacked a contiguous riparian buffer. In contrast, sites where we detected *P. tanasi* in the Little River had few macrophytes, little silt, and a predominantly intact riparian zone. Moreover, we collected several other rare darters (*Etheostoma percnurum* Jenkins, *E. vulneratum* Cope, *P. aurantiaca* Cope, *P. burtoni* Fowler, *P. evides* Jordan and Copeland, *P. williamsi* Page and Near) at these sites, suggesting that habitat and water quality were good. Similarly, much of the 18-km-long reach of South Chickamauga Creek that we sampled was heavily silted and lacked a riparian zone; we collected *P. tanasi* only in a 4.5-km-long section with little silt and a well established riparian zone. We found little silt and abundant macrophyte-free gravel substrate at sites where we collected the greatest numbers of *P. tanasi* in the French Broad and Hiwassee rivers.

Acknowledgments

The authors would like to acknowledge B. Brown, J. Damer, B. Davis, E. Dotterer, E. Dyer, J. Hunt, J. Kerns, V.M. Mengel, K. Moles, C. Morton, E. Rahm, T.R. Russ, S. Saha, A. Weber, N. Welte, and J. Westhoff for assisting with sampling. The United States Fish and Wildlife Service provided funds for this study. Ed Scott provided assistance in the field and knowledgeable discussions. Ed Scott, Charlie Saylor, and Bo Baxter provided valuable data regarding TVA collections of *P. tanasi*. Dr. David Etnier, Ed Scott, and an anonymous reviewer provided valuable comments on an earlier draft. Finally, there were many gracious landowners who granted us access to sampling sites.

Literature Cited

BIGGINS, R. G., AND R. B. EAGER. 1983. Snail darter recovery plan. US Fish and Wildlife Service, Asheville, North Carolina.

EAGER, R. B. 1982. A report on the status of the endangered snail darter, *Percina tanasi*. US Fish and Wildlife Service Report. Norris, Tennessee.

ETNIER, D. A. 1976. *Percina* (*Imostoma*) *tanasi*, a new percid fish from the Little Tennessee River, Tennessee. Proc. Biol. Soc. Washington., 88:469–488.

ETNIER, D. A., AND W. C. STARNES. 1993. The fishes of Tennessee Univ. Tennessee Press, Knoxville, Tennessee.

HAAG, W. L., AND M. L. WARREN. 2006. Seasonal feeding specialization on snails by river darters (*Percina shumardi*) with a review of snail feeding by other darter species. Copeia, 2006:604–612.

HARNED, D. W. 1979. A qualitative survey for fish and macroinvertebrates of the French Broad River and selected tributaries, June–August 1977. Technical Note B35, Office of Nat. Resources, Tennessee Valley Authority, Norris, Tennessee. 37 p.

ROBINSON, H. W., AND T. M. BUCHANAN. 1988. Fishes of Arkansas Univ. Arkansas Press, Fayetteville.

SCOTT, E. M. 2003. Snail darter monitoring program in Douglas dam tailwater, 2003. TVA River Sys. Oper. and Env., Tennessee Valley Authority, Norris, Tennessee.

SCOTT, E. M., K. D. GARDNER, J. T. BAXTER, AND B. L. YEAGER. 1996. Biological and water quality responses in tributary tailwaters to dissolved oxygen and minimum flow improvements. Res. Group, Wat. Mgnt., Tennessee Valley Authority, Norris, Tennessee.

STARNES, W. C. 1977. The ecology and life history of the endangered snail darter, *Percina* (*Imostoma*) *tanasi* (Etnier). PhD dissert., Univ. Tennessee, Knoxville, Tennessee.

TOMLJANOVICH, D. A., AND C. F. SAYLOR. 1989. Results of fisheries investigations in Douglas tailwater, August 1987–September 1988. Technical Report TVA/WW/AB-89/6. Wat. Res., Tennessee Valley Authority, Norris, Tennessee.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY. 1994. The quality of our nation's water: A summary of the 1992 National Water Quality Inventory. US EPA, Washington, DC.

WATERS, T. F. 1995. Sediment in streams: Sources, biological effects, and control Monograph 7, American Fisheries Society, Bethesda, Maryland.

YEAGER, B. L., AND D. A. TOMLJANOVICH. 1990. Biological investigations in Douglas and Cherokee tailwaters–FY 1989. Technical report TVA/WR/AB-90/7. Wat. Res., Tennessee Valley Authority, Norris, Tennessee.