

11-1-1984

Fishes of the North Fork Holston River System, Virginia and Tennessee

Joe C. Feeman Jr.

Follow this and additional works at: <https://trace.tennessee.edu/sfcproceedings>



Part of the [Marine Biology Commons](#)

Recommended Citation

Feeman, Joe C. Jr. (1984) "Fishes of the North Fork Holston River System, Virginia and Tennessee," *Southeastern Fishes Council Proceedings*: No. 16.

Available at: <https://trace.tennessee.edu/sfcproceedings/vol1/iss16/3>

This Original Research Article is brought to you for free and open access by Volunteer, Open Access, Library Journals (VOL Journals), published in partnership with The University of Tennessee (UT) University Libraries. This article has been accepted for inclusion in Southeastern Fishes Council Proceedings by an authorized editor. For more information, please visit <https://trace.tennessee.edu/sfcproceedings>.

Fishes of the North Fork Holston River System, Virginia and Tennessee

shed for a number of years relative to flood control. Studies by Boschung (1976, 1979b) were utilized in the decision to revise the SCS's original plan. The final watershed plan was developed in concert with other federal agencies, including various offices of the U.S. Fish and Wildlife Service, to ensure that the results of SCS's flood-control plan will not adversely affect the slackwater darter.

Conservation measures. Habitat preservation obviously is of prime importance in conservation of the slackwater darter. The fact that it inhabits relatively small to moderate-sized streams may be regarded as an advantage; such streams are easily monitored, and the disjunct occurrence of populations makes the species less subject to widespread eradication resulting from a major ecological disaster (e.g., a massive chemical or oil spill) than would be true for a big-river species. On the other hand, reproductive success of this fish is dependent more than for most species upon maintenance of proper groundwater levels, which are not easily controlled. Intelligent water conservation methods are required, which should not involve widespread dam building. Finally, this species probably could be cultured successfully in a hatchery, providing care is taken to regulate water levels on a seasonal basis.

Acknowledgments

Most of our knowledge of the distribution and biology of the slackwater darter resulted from studies sponsored by the U. S. Department of Agriculture, Soil Conservation Service, Auburn, AL. Thomas S. Jandebeur, who made numerous collections in the south bend of the Tennessee River in search of the darter, is responsible for its discovery in Swan Creek. Also, Tom was the senior author's able companion in the field on numerous occasions, as were Mason Dollar, John Hall, Leroy Koch, Patrick O'Neil, Benjamin Wall, James D. Williams, and John S. Williams. Additional collectors were J. A. Collins, Larry Davenport, Christopher Dyer, Mike Carroll, Thomas Gritzmacher, Benjamin Richey, George Smith, Fred Tatum, and John Weaver. Lawrence Page shared his knowledge of the slackwater darter in Shoal Creek. We thank these friends and colleagues for their valuable contributions to this study.

Literature Cited

Boschung, H. T. 1976. An evaluation of the slackwater darter, relative to its range, critical habitat, and reproductive habitat in the Cypress Creek watershed

- and adjacent stream systems. USDA Soil Conservation Service, Auburn, Alabama. 50 pp.
- Boschung, H. T. 1979a. Notes on the distribution and life history of the slackwater darter, *Etheostoma boschungii* (Percidae). ASB Bull. 26(2):67.
- Boschung, H. T. 1979b. Report on the breeding habits of the slackwater darter (Percidae: *Etheostoma boschungii*) in the Cypress Creek watershed. USDA Soil Conservation Service, Auburn, Alabama. 26 pp.
- Boschung, H. T. 1980. *Etheostoma boschungii* Wall and Williams, Slackwater darter. p. 630 in D. S. Lee et al. *Atlas of North American Freshwater Fishes*. N. C. State Mus. Nat. Hist., Raleigh, x + 854 pp.
- Boschung, H. T. 1984. Recovery Plan for the Slackwater Darter. U. S. Fish and Wildlife Service, Atlanta. 45 pp.
- Boschung, H. T., J. D. Williams, D. W. Gotshall, D. K. Caldwell and M. C. Caldwell. 1983. *The Audubon Society Field Guide to North American Fishes, Whales, and Dolphins*. Alfred A. Knopf, Inc., New York. 848 pp., 684 pls.
- Deacon, J. E., G. Kobetich, J. D. Williams and S. Conteras. 1979. Fishes of North America endangered, threatened, or of special concern: 1979. *Fisheries* 4(2):30-44.
- Kuehne, R. A. and R. W. Barbour. 1983. *The American Darters*. Univ. Press of Kentucky, Lexington. 216 pp.
- Page, L. M. 1983. *Handbook of Darters*. T. F. H. Publications, Inc., Neptune City, N. J. 271 pp., 38 pls., 89 maps.
- Pianka, E. 1973. The structure of lizard communities. *Ann. Rev. Sys. and Ecol.* 1973(4):53-74.
- Ramsey, J. S. 1976. Freshwater fishes. In: Boschung, H. T., ed., *Endangered and threatened plants and animals of Alabama*. Bull. Alabama Mus. Nat. Hist. 2: 53-65.
- Starnes, W. C. and D. A. Etnier. 1980. Fishes. In: *Tennessee's rare wildlife*. Vol. I: The vertebrates. Tenn. Wildlife Resources Agency, Nashville. pp. B1-134.
- Ultsch, G. R., H. T. Boschung and M. A. Ross. 1978. Metabolism, critical oxygen tension, and habitat selection in darters (*Etheostoma*). *Ecology* 59(1): 99-107.
- Wall, B. R. and J. D. Williams. 1974. *Etheostoma boschungii*, a new percid fish from the Tennessee River drainage in northern Alabama and western Tennessee. *Tulane Stud. Zool. Bot.* 18(4):177-182.
- Williams, J. D. and H. W. Robison. 1980. *Ozarka*: a new subgenus of *Etheostoma* (Pisces: Percidae). *Brimleyana* 4:149-156.

FISHES OF THE NORTH FORK HOLSTON RIVER SYSTEM, VIRGINIA AND TENNESSEE

Joe C. Feeman, Jr.
Tennessee Valley Authority
Norris, Tennessee 37828

Abstract

Recent surveys by the Tennessee Valley Authority (over 100 collections from 1971-1983), along with extensive historical collections, have shown the North Fork of the Holston River system to have a diverse fish fauna. Annotated accounts of 73 species, representing 11 families, are presented along with comments on distribution, habitat preference, and protective status. A discussion of past disturbances and their effects on the fish fauna are also presented.

Introduction

Since 1971 personnel of the Tennessee Valley Author-

ity (TVA) have taken over 100 fish samples in the North Fork of the Holston River system. Samples were taken from 1971-1977 in order to monitor faunal recovery from pollution and to determine mercury levels assimilated by the fishes. From 1977-1983 collections were taken in conjunction with various other projects, including a search for suitable transplant sites for *Conradilla caelata* (Conrad), an endangered mussel species, and collections of selected fish species for research in mussel life history studies.

Numerous other collectors have sampled the North Fork system, beginning with Cope's collections in October 1867 (Cope 1868). Other publications dealing with fish collections in this system include Jordan (1889), Patrick (1961), Ross and Carico (1963), Hill et al. (1975), and Feeman (1980). Collection records that have not been reported in the literature were obtained from R. E. Jenkins. Also included are early TVA collections taken in the 1930's by A. R. Cahn, C. C. Davis, and E.R. Cady. The purpose of this paper is to present a compre-

hensive, annotated account of the fish fauna known from the North Fork of the Holston River system, including relative abundance, distribution, habitat preference, and protected status.

Description of Study Area

Located in the Ridge and Valley physiographic region of southwestern Virginia and northeastern Tennessee, the North Fork of the Holston River system is bounded on the northwest by the Clinch and Powell river systems, on the southeast by the Middle Fork of the Holston River system (all in the Tennessee River drainage), and on the east by the New River system (Ohio River drainage). It arises in Bland County, Virginia, and flows 193 kilometers to Sullivan County, Tennessee, where it joins the South Fork to form the Holston River proper, a large headwater tributary of the Tennessee River.

The system drains 1,888 km² and is dominated by hardwood forests on steep slopes, with narrow strips of farmland along most of the river. The North Fork is characterized by long sluggish pools and swift riffles, and has an average gradient of 1.9 m/km. It is a typical Appalachian stream, with tributaries of varying size and gradient. Aquatic vegetation is common in the lower portions of the main river and in lowland tributaries, with vegetation in some pool areas becoming so concentrated by the end of the summer that they appear to be islands. Average flow for the North Fork is 25.1 m³/sec. Average rainfall is 103.6 cm, with October the driest month (5.6 cm) and July the wettest (10.9 cm).

Table 1 gives specific locality information for the TVA sampling sites (1971-1984), and includes river mile (RM) measured upstream from junction with the South Fork (Stas. 1-25) or North Fork (Stas. 26-34) of the Holston River.

Materials and Methods

A variety of collection methods was used to sample a total of 25 main river sites and 8 tributary sites (Figure 1, Table 1). From 1971-1977, a total of 80 rotenone samples were taken at 24 sites, including 9 samples on 8 tributaries. All of these samples were taken quantitatively by blocking the upstream and downstream limits with 5 mm square mesh block nets and treating with 5 percent emulsifiable rotenone at a rate not less than 0.5 mg/l at the upper net. Rotenone was neutralized at the lower net with an equal volume of potassium permanganate. Fish were then picked up, sorted to species, enumerated and weighed. Minnows and other small fish were preserved in 10% formalin, and returned to the laboratory for identification. Specimens of unknown or uncertain identity were examined by Dr. Robert E. Jenkins, of Roanoke College.

Since 1977, approximately 20 samples have been taken by various other collection methods at 10 additional sites (Figure 1, Table 1). Methods of collection include: day and night backpack electrofishing, both in swift current into a 20 ft. seine and along bank areas and pools; seine-snorkel method (Hickman and Saylor 1984) for quantitative sampling; qualitative snorkeling; and seine hauling. After capture, fishes were identified and counted. Fishes of uncertain or difficult identification and voucher specimens of most species were preserved in 10% formalin and returned to the laboratory for identification and curation.

Nomenclature used in this paper follows Robins et al. (1980).

Table 1. TVA Sampling Stations,
North Fork Holston River, 1971-1984.

1. RM 0.2, left side of small island, 200 yds upstream from U.S. hwy. 11 bridge, Sullivan Co., TN. 3 samples (1975-1977). Species: 9,13-16,19-24,27,29-30,38,42,44-45,48-51,55,59-60,64-67,70,73.
2. RM 4.8, 0.2 river mi. upstream from co. rd. 2462 bridge, at Cloud Ford, 0.1 mi. downstream from st. line, Sullivan Co., TN. 11 May 1983. Species: 9,13,15-16,19-22,24,27,29-30,38-40,42,44-45,50-51,55,59-60,63-67,70,73.
3. RM 6.2, right side of and below island at end of co. rd. 821, 0.4 mi. upstream from st. line, Scott Co., VA. May, June, July 1981. Species: 9,13-16,19-24,26-27,29-30,33,38,42,44-45,50-51,53-56,59-60,64-67,70,73.
4. RM 6.3, left side of island at end of co. rd. 821, 0.4 mi. upstream from st. line, Scott Co., VA. 14 samples (1971-1976). Species: 4,9-10,12-16,18-24,26-30,32,34-36,38,41-42,44-45,48-51,53-55,57,59-60,64-67,70-71,73.
5. RM 7.7, off co. rd. 614, 0.7 rd. mi. from jct. with U.S. hwy. 23 at Weber City, Scott Co., VA. 17 Aug. 1981. Species: 9,13,16,19-24,27,29-30,38,50-51,55,59,64-65,73.
6. RM 13.4, right side of island off co. rd. 778, 0.3 rd. mi. E of jct. with co. rd. 614, Scott Co., VA. 5 samples (1973-1977). Species: 9,13-14,16,18-24,26-27,29-30,34-35,38,42,44-45,48-51,53-55,59,64-67,70,73.
7. RM 18.1, right side of island off co. rd. 614, 1.0 rd. mi. S of jct. with U.S. hwy. 421, Scott Co., VA. 3 Aug. 1976. Species: 9-10,13-14,16,19-24,27,29-30,38,42,44-45,48,50-51,55-59,64-66,70,73.
8. RM 21.9, just above and below U.S. hwy. 421 bridge at Hilton, Scott Co., VA. 17 Aug. 1981. Species: 9,13,16,19-22,24,27,29-30,38-40,50-51,55,59,64-65,67,73.
9. RM 25.7, left side of island 0.75 rd. mi. N of U.S. hwy. 421, at island across from Blue Springs Branch at Old Ford, Scott Co., VA. 4 Aug. 1976. Species: 9,13-14,16,19-24,27,29-30,38,42,44,48,50,55,59,64-66,73.
10. RM 36.7, both sides of island and ca. 0.25 mi. downstream, 0.3 river mi. upstream from Martin Ford, 1.0 air mi. SW of Mendota, Washington Co., VA. Aug. 1981. Species: 9,13-14,16,19-24,27,29-30,38,42,50-51,55,59,64-65,67,70,73.
11. RM 36.8, right side of island, 0.5 rd. mi. S of co. rds. 614 & 615, on co. rd. 615, 1.0 air mi. SW of Mendota, Washington Co., VA. Species: 9,13-14,16,18-24,27,29-30,38,42,44,48,50,55,59,64-66,70,73.
12. RM 48.6, left side of island, off co. rd. 614, 100 yds. SW of co. rds. 614 & 623, Washington Co., VA. 4 samples (1973-1975). Species: 9,13-14,16,18-24,27-30,34-35,38,42,44,48-51,53,55,59,64-66,70,73.
13. RM 56.3, left side of island off co. rd. 802, 2.5 rd. mi. S of jct. with U.S. hwy. 19, Washington Co., VA. Species: 9,13-14,16,18-24,27,29-30,34-35,38,42,44,49-51,53,55,59,64-66,70,73.
14. RM 59.3, ca. 0.5 river mi. downstream from U.S. hwy. 19 bridge at Holston, Washington Co., VA. Species: 9,13,16,19-22,24,27,38-40,50-51,53,55,59,64-65,67,73.
15. RM 69.7, 200 yds. upstream from hwy. 80 bridge at Hayters Gap, Washington Co., VA. 6 samples (1971-1975). Species: 5,9,13,16,18-22,24,26-30,34-35,38,42,44,48,50-51,53-57,59,64-67,70,73.
16. RM 72.0, left side of island off co. rd. 611, 4.0 mi. NE of jct. with hwy. 80, Washington Co., VA. 10 samples (1973-1977). Species: 9,13,16,18-22,24-27,29-30,34-35,38,42,44,47,49-51,53-55,59,63-66,69-70,73.
17. RM 74.4, 0.6 river mi. upstream from mouth of Big Cr., off co. rd. 611, Washington Co., VA. 18 Aug. 1981. Species: 9,12-13,16,19-22,24,27,29,38,44,47,50-51,53,55,59,64-65,67,73.
18. RM 76.5, both sides of island off co. rd. 611, 1.6 river mi. below mouth of Tumbling Cr., Washington Co., VA. 5 samples (1973-1977). Species: 9,13,16,19-22,24,26-27,29-30,34-35,37-38,42,44,47-51,53,55-56,59,61,64-66,68,70,72-73.
19. RM 76.9, 1.3 river mi. below mouth of Tumbling Cr., off co. rd. 611, Washington Co., VA. 18 Aug. 1981. Species: 9,13,16,19-22,24,27,29,38-40,47,50,55,59,64-65,67,73.
20. RM 80.1, just below sludge ponds on co. rd. 611 near Saltville, Washington Co., VA. 1 sample (1975). Species: 9,13,16,19-24,27,29-30,38,42,47-48,53,55,59,73.
21. RM 85.2, both sides of island, 0.6 river mi. up-

- stream from st. rt. 91 bridge at Saltville, Smyth Co., VA. May, June, July 1981. Species: 1, 9, 13, 16, 19-24, 27, 29, 38, 47, 50, 53, 55, 59, 64-65, 67, 69, 73.
22. RM 88.6, just below Neil Bridge on co. rd. 633, 0.5 rd. mi. S of jct. with st. rt. 91, Smyth Co., VA. 3 samples (1971-1975). Species: 8-9, 13, 16, 18-24, 26-30, 34-35, 38, 47-51, 53-59, 63-65, 69, 71, 73.
23. RM 91.4, off st. rt. 91 at Old Broad Ford, 4.5 rd. mi. NE of McCready, Smyth Co., VA. 8 samples (1974-1977). Species: 7, 9, 13, 16, 19-24, 27, 29-30, 34-35, 38, 47-50, 53-55, 59, 63-67, 68-69, 71, 73.
24. RM 97.9, at horse show arena just below co. rd. bridge at Riverside, Smyth Co., VA. 18 Aug. 1981. Species: 9, 13, 16, 19-22, 24-25, 27, 38, 47, 50, 55, 59, 64-66, 73.
25. RM 107.4, just above co. rd. 687 bridge at Chatham Hill, Smyth Co., VA. 3 samples (1975-1977). Species: 9, 13, 16-19, 22, 24-25, 27, 30, 32, 34-35, 37-38, 49-50, 54-56, 59, 64-66, 73.

Tributary Stations

26. Possum Cr., RM 2.4, off co. rd. 639, 1.0 rd. mi. S of jct. with co. rd. 614, Scott Co., VA. 2 Aug. 1976. Species: 9, 13, 16, 19-22, 27, 38, 50-51, 55, 59, 64-66, 73.
27. Big Moccasin Cr., RM 9.0, 0.4 rd. mi. W of st. rt. 71, on co. rd. 669 near Antioch Church, Scott Co., VA. 13 Sept. 1973. Species: 9, 13, 16, 19-22, 27, 34, 38, 46, 50-51, 53, 55, 59, 64-65, 73.
28. Big Moccasin Cr., RM 44.8, off co. rd. 679, 2.0 rd. mi. NE of jct. with co. rd. 613, Russell Co., VA. 14 Sept. 1973. Species: 9, 13, 16, 19-22, 27, 34, 38, 42, 50, 53, 55, 59, 61, 64-65, 73.
29. Cove Cr., RM 0.2, 1.0 rd. mi. W of Beech Grove School, off U.S., hwy. 421, Scott Co., VA. 4 Aug. 1976. Species: 9, 13, 16, 19-22, 27, 38, 42, 50-51, 55, 59, 64-66, 73.
30. Abrams Cr., RM 1.0, at mouth of Little Wolf Run Cr., just below railroad trestle on co. rd. 6290, 0.1 rd. mi. NE of jct. with co. rd. 616, Washington Co., VA. 6 Aug. 1976. Species: 9, 13, 16, 19-22, 25, 27, 34-35, 37-38, 50, 53, 55, 59, 64-66, 73.
31. Brumley Cr., RM 0.2, 0.1 rd. mi. S of jct. of co. rds. 687 & 611, at co. rd. 611 bridge, Washington Co., VA. 5 Sept. 1976. Species: 5-6, 9, 13, 16, 19-22, 25, 27, 34, 38, 42, 50-51, 55, 59, 64-65, 73.
32. Beaver Cr., RM 0.1, just above mouth, Smyth Co., VA. 10 Aug. 1976. Species: 9, 13, 16, 19-22, 25, 27, 34-35, 38, 47, 50, 55, 59, 64-65, 73.
33. Laurel Cr., RM 5.5, 4.5 rd. mi. N of st. rt. 42, on st. rt. 91, Tazewell Co., VA. 5 Sept. 1973. Species: 9, 13, 16, 19-22, 27, 35, 38, 46, 50, 55, 59, 61, 64-65, 68, 73.
34. Lick Cr., RM 1.0, off co. rd. 620, 1.0 rd. mi. N of jct. with st. rt. 42, Smyth Co., VA. 11 Aug. 1976. Species: 9, 13, 16, 19-22, 25, 27, 32, 35, 37-38, 47, 50-51, 54-55, 59, 61, 64-65, 72-73.

Species included in this list represent the following families: Petromyzontidae (lampreys) (1-3), Clupeidae (herrings) (4), Salmonidae (trout) (5-7), Esocidae (pikes) (8), Cyprinidae (carps and minnows) (9-35), Catostomidae (suckers) (36-41), Ictaluridae (catfishes) (42-48), Cyprinodontidae (killifishes) (49), Centrarchidae (sunfishes and black basses) (50-58), Percidae (perches) (59-71), Cottidae (sculpins) (72-73).

1. *Ichthyomyzon bdellium* (Jordan) - Ohio lamprey. Four specimens were collected at RM 85.2 in 1981. These were identified by the author, but were lost in shipment to Dr. R. E. Jenkins. One specimen was collected by H. R. Becker et al in 1928 above Saltville (Hubbs and Trautman (1937), and more recently (1981) by Jim Wadlak at RM 86.9 (R. E. Jenkins, pers. comm.). Station: 21.

2. *Ichthyomyzon greeleyi* Hubbs and Trautman - mountain brook lamprey. A single specimen of this nonparasitic lamprey was taken by R. E. Jenkins just above Saltville (RM 82) in 1972.

3. *Lampetra appendix* (DeKay) - American brook lamprey. The specimen reported by Ross and Carico (1963) from Riverside, 6 mi. from Chatham Hills, was subsequently reexamined by R. E. Jenkins and found to be an *Ichthyomyzon ammocoete*, either *I. bdellium* or *I. greeleyi*. One adult *L. appendix*, taken in 1972 from Sprout Creek, just above its mouth, Washington Co., Va., was identified by R. E. Jenkins (pers. comm.).

4. *Dorosoma cepedianum* (Lesueur) - gizzard shad. Several individuals were taken at RM 6.3. Station: 4.

5. *Salmo gairdneri* Richardson - rainbow trout. Rainbow trout have been introduced into several tributaries of the North Fork, and are being managed by the Virginia Game and Inland Fisheries Commission. Stations: 15, 31.

6. *Salmo trutta* Linnaeus - brown trout. Introduced. Several individuals were taken in Brumley Creek, which is managed for trout by the State. Station: 31.

7. *Salvelinus fontinalis* (Mitchill) - brook trout. According to Cope (1868), brook trout were not native to the North Fork system. The species has been introduced into several tributaries by the state of Virginia. Station: 23.

8. *Esox masquinongy* Mitchill - muskellunge. Introduced by the state of Virginia, one small individual was taken at RM 88.6 in 1973. Station: 22.

9. *Camptostoma anomalum* (Rafinesque) - central stoneroller. The stoneroller was the most abundant and widespread fish taken, occurring in all TVA samples. It was most abundant over a small to medium-sized rubble substrate in riffles with moderate current. Stations: all.

10. *Carassius auratus* (Linnaeus) - goldfish. Introduced; taken at two sites. Stations: 4, 7.

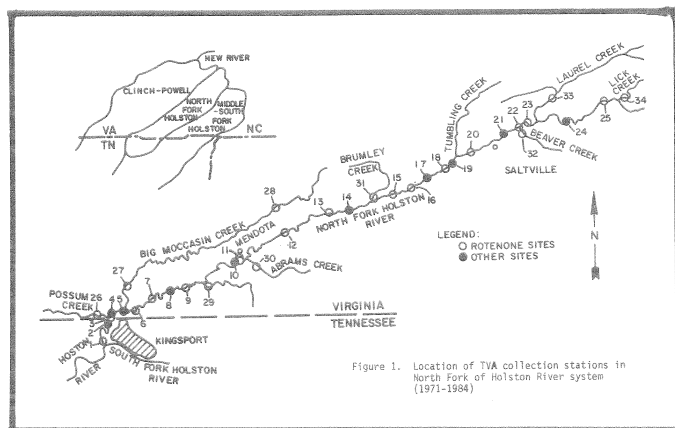
11. *Clinostomus funduloides* Girard - rosyside dace. The only known population of this cyprinid in the North Fork system is in Lick Creek, a large, cool headwater stream. Two collections have been made, the most recent in 1976 by R. E. Jenkins off rt. 625, 1.8 air miles NNW of Ceres, Bland Co., Va.

12. *Cyprinus carpio* Linnaeus - carp. Introduced. This large cyprinid was collected in the main river. Stations: 4, 17.

13. *Hybopsis amblops* (Rafinesque) - bigeye chub. Abundant throughout the system in pools over small rock or rubble substrate and in silty backwater areas. Stations: all.

14. *Hybopsis dissimilis* (Kirtland) - streamline chub. This chub is common in runs with moderate to swift current over small rock or rubble substrate in the main river. Its preference for moderate to large rivers is illustrated in the North Fork system, where it is absent above RM 91.4. Stations: 1, 3-4, 6-7, 9-13.

15. *Hybopsis monacha* (Cope) - spotfin chub. The North Fork apparently has one of the strongest extant populations of this chub, which is listed as threatened by the U.S. Fish and Wildlife Service. It has been collected over pea-sized gravel substrate on shoals from the mouth to RM 88.6 (historically). Stations: 1-4.



16. Nocomis micropogon (Cope) - river chub. Abundant throughout the system, usually in riffles and runs over boulder and rubble substrate. Stations: all.

17. Notropis ardens (Cope) - rosefin shiner. The only record for this species in the North Fork system is a collection of 16 juveniles in Possum Creek, about 0.25 miles above the mouth, Scott County, Virginia, 13 May 1967, by R. E. Jenkins.

18. Notropis arionmmus (Cope) - popeye shiner. This species, which Gilbert (1969) did not record from Virginia, is common in the lower North Fork. It becomes increasingly less common upstream as the river becomes smaller, with no specimens being collected above RM 91.4. Most often found in pools and runs with slight current. Gilbert (1969) indicated this to be one of a small number of eastern North American fishes characteristically found over a gravel substrate. Listed as of special concern in Virginia (Jenkins and Musick 1980). Stations: 4,6,11-13,15-16,22.

19. Notropis chrysocephalus chrysocephalus (Rafinesque) - northern striped shiner. Common throughout the North Fork system in a variety of pool habitats. Stations: all.

20. Notropis coccogenis (Cope) - warpaint shiner. Common throughout the main river and its tributaries, usually in or near swift riffles with large rubble or rock substrate. Stations: all.

21. Notropis galacturus (Cope) - whitetail shiner. Found in moderate numbers throughout the North Fork system in swift riffles over a variety of substrates, including bedrock. Stations: all.

22. Notropis leuciodus (Cope) - Tennessee shiner. Common throughout the North Fork system in a variety of riffle habitats. Stations: all.

23. Notropis photogenis (Cope) - silver shiner. Taken in the main river, usually in low numbers, in deep pools with moderate current over gravel or rubble substrate. Stations: 1-25.

24. Notropis rubellus (Agassiz) - rosyface shiner. The most abundant shiner in the main river, but absent from tributaries. This species prefers riffles and runs with gravel or rubble substrate. Stations: 1-25.

25. Notropis rubricroceus (Cope) - saffron shiner. This montane species was common in the upstream tributaries, but was only taken occasionally in the main river. It was collected in a variety of habitats. Stations: 16,24-25,30-32,34.

26. Notropis spilopterus (Cope) - spotfin shiner. Taken at several localities in low numbers, usually in pool habitats. Stations: 3-4,6,15-16,18,22.

27. Notropis telescopus (Cope) - telescope shiner. Abundant and widespread in pools and runs of the North Fork system. Stations: all.

28. Notropis volucellus (Cope) - mimic shiner. Rare in the North Fork system, where it was only taken at four localities. Generally prefers pools with moderate current over a gravel/rubble substrate. Stations: 4,12,15,22.

29. Notropis new species - sawfin shiner. This undescribed species prefers larger sections of the main river, where it was found to be abundant in variety of habitats (pools, backwaters, and riffles). Ross and Carico's (1963) record of the similar Notropis spectrun-culus (Cope) from Big Moccasin Creek has since been found by Michael Masnik to have been based on N. leuciodus. The sawfin shiner occurs in both the Cumberland and Tennessee river drainages. Stations: 1-13,15-23.

30. Phenacobius uranops Cope - stargazing minnow. Found commonly in runs and riffles with moderate current over a gravel substrate throughout the main river. Stations: 1-13,15-16,18,20,22-23,25.

31. Ploxinus oreas (Cope) - mountain redbelly dace. Ross and Carico (1963) reported this species (based on a 1955 collection) from a small tributary, 1 mi. N of Pine Grove, but specimens were unavailable for examination. This species was also collected in Lick Creek by Monte Seehorn in 1973 (two collections) and by R. E. Jenkins in 1976 (one collection). These specimens represent an undescribed subspecies that is native to the upper Tennessee River drainage (R. E. Jenkins, pers. comm.).

32. Pimephales notatus (Rafinesque) - bluntnose

minnow. Found in large numbers at RM 107.4 and in Lick Creek, but only collected at one other site (RM 6.3). Taken in both backwater areas over silty substrate and in riffles with sand and gravel substrate. Stations: 4,25,34.

33. Pimephales vigilax (Baird and Girard) - bullhead minnow. Although this species is to be expected in the area, this nevertheless represents the first collection from the North Fork system, and only the fourth collection of P. vigilax from Virginia. A total of five specimens were taken at RM 6.2 in a pool over sand and gravel substrate. Station: 3.

34. Rhinichthys atratulus (Hermann) - blacknose dace. A common inhabitant of headwater streams and small tributaries, but uncommon in the main river and in larger tributaries. It was collected from a variety of habitats. Stations: 4,6,12-13,15-16,18,22-23,25,27-28,30-32.

35. Semotilus atromaculatus (Mitchill) - creek chub. The creek chub shows a preference for small streams, where it is common, but it was only rarely collected in the main river and large tributaries. Stations: 4,6,12-13,15-16,18,22-23,25,30,32-34.

36. Carpodius cyprinus (Lesueur) - quillback. Several individuals were taken at RM 6.3 in spring samples, probably during the spawning run. Station: 4.

37. Catostomus commersoni (Lacepede) - white sucker. Found in moderate numbers in tributaries and headwater sections of the main river, where it usually occurred in runs with a rubble/rocky substrate. Stations: 18,25,30,34.

38. Hypentelium nigricans (Lesueur) - northern hog sucker. Abundant throughout the North Fork system in riffles of varying current over a gravel and rubble substrate. Stations: all.

39. Moxostoma duquesnei (Lesueur) - black redhorse. Stations: 1,3-7,9-13,15-18,20-34.

40. Moxostoma erythrurum (Rafinesque) - golden redhorse. Both M. erythrurum and M. duquesnei were collected in moderate numbers throughout most of the North Fork system. They were taken in a variety of habitats. Stations: 1,3-7,9-13,15-18,20-34.

41. Moxostoma macrolepidotum (Lesueur) - shorthead redhorse. Although present in adjacent areas of Virginia, there is only one apparent record from the North Fork system. One specimen (no longer extant), taken from RM 6.3, is regarded by R. E. Jenkins (pers. comm.) as probably representing a valid record, based on other confirmed records of the species from closely adjacent localities outside the system. Station: 4.

42. Ictalurus natalis (Lesueur) - yellow bullhead. Common in a variety of pool habitats throughout most of the North Fork system, where probably native (R. E. Jenkins, pers. comm.). Stations: 1-4,6-7,9-13,15-16,18,20,28-29,31.

43. Ictalurus nebulosus (Lesueur) - brown bullhead. The only collection of this species, which is rare in the upper Tennessee River drainage, was made in 1981 by Jim Wadlak (unpublished M.Sc. thesis, VPI) at North Holston Ford (RM 86.9) (R. E. Jenkins, pers. comm.). Originally identified as I. melas, it was later reidentified as I. nebulosus by Jenkins, who considers it to be introduced.

44. Ictalurus punctatus (Rafinesque) - channel catfish. Taken only in small numbers in the main river. Most were juveniles, collected in pools with vegetation. Stations: 1-4,6-7,9,11-13,15-18.

45. Noturus eleutherus Jordan - mountain madtom. This species was common in riffles over gravel substrate, often associated with aquatic vegetation. Populations virtually disappear upstream above RM 18.1. Stations: 1-4,6-7.

46. Noturus flavus Rafinesque - stonecat. Ten specimens of N. flavus were taken from pools with bedrock and boulder substrate. LeGrande and Cavender (1980) have shown that specimens from the Tennessee River drainage usually have two more chromosomes (50 vs. 48) than those from elsewhere. Stations: 27,33.

47. Noturus insignis (Richardson) - margined madtom. This large madtom occurs in moderate numbers in both pools and riffles above RM 69.7. It is native to Atlan-

tic slope drainages (Taylor 1969), and its presence in the North Fork appears to be a result of bait bucket introduction. Stations: 16-24,32,34.

48. Pylodictis olivaris (Rafinesque) - flathead catfish. Common in deep sluggish pools throughout the main river. Stations: 1,4,6-7,9,11-12,15,18,20,22-23.

49. Fundulus catenatus (Storer) - northern studfish. The northern studfish was taken in backwaters and sluggish pools adjacent to the main river. One specimen was also collected in Laurel Creek. Stations: 1,4-6,12-13,16,18,22-23,25.

50. Ambloplites rupestris (Rafinesque) - rock bass. Common throughout the North Fork system in pools and runs. Stations: 1-19,21-34.

51. Lepomis auritus (Linnaeus) - redbreast sunfish. Native to the Atlantic slope. Introduced into this area and now common throughout most of the North Fork system. Stations: 1-8,10,12-18,22,26-27,29,31,34.

52. Lepomis cyanellus Rafinesque - green sunfish. One specimen collected by William S. Woolcott in Logan Creek, ca. 1.0 mi. E of Hayters Gap, Washington Co., Virginia, 9 July 1963. This is a puzzling record, since there have been no other collections of this often abundant species in the North Fork system. Most likely this represents an introduction.

53. Lepomis macrochirus Rafinesque - bluegill. Common throughout the North Fork system, usually in pools. Stations: 3-4,6,12-18,20-23,27-28,30.

54. Lepomis megalotis (Rafinesque) - longear sunfish. Taken throughout the North Fork system in small numbers. Stations: 3-4,6,15-16,22-23,25,34.

55. Micropterus dolomieu Lacepede - smallmouth bass. This popular gamefish was found throughout the system in a variety of habitats, although characteristically it occurs in open, flowing water over a rock/rubble bottom. The population appears to have increased greatly since closure of an Olin Corporation plant at Saltville. Stations: all.

56. Micropterus punctulatus (Rafinesque) - spotted bass. Only a few individuals were taken at scattered localities in the main river. Stations: 3,15,18,22,25.

57. Micropterus salmoides salmoides (Lacepede) - northern largemouth bass. Taken only at three localities (RM 6.3, 69.7, 88.6). Stations: 4,15,22.

58. Pomoxis nigromaculatus (Lesueur) - black crappie. A single specimen was taken at RM 88.6. Station: 22.

59. Etheostoma blennioides Rafinesque - greenside darter. This darter was common at all sites sampled, where it usually was found in riffles over a variety of substrates. Stations: all.

60. Etheostoma camurum (Cope) - bluebreast darter. The bluebreast darter was collected in a variety of habitats. They were taken in low numbers in riffles with gravel substrate, but in swift riffles with rubble substrate (RM 0.2, 6.2, 85.2) they were abundant. Listed as of special concern in Virginia (Jenkins and Musick 1980). Stations: 1-4.

61. Etheostoma flabellare Rafinesque - fantail darter. Collected from tributaries, where it inhabits both pools and riffles, usually over bedrock and/or boulder substrates. Stations: 18,28,33-34.

62. Etheostoma meadiae (Jordan and Evermann) - no common name. Cahn and Davis collected this darter from Cove Creek in 1937. The only other collection was made by R. D. Ross, who collected one large specimen in Possum Creek. Our samples from these two tributaries failed to produce this species. Listed as either Etheostoma jessiae or E. stigmatum in the past, recognition of E. meadiae as a distinct species is based on unpublished studies by Dr. W. M. Howell. According to R. E. Jenkins (pers. comm.), it will continue to be listed as E. stigmatum in Jenkins and N. H. Burkhead's upcoming book on Virginia fishes. Listed as of special concern in Virginia (as Etheostoma jessiae) (Jenkins and Musick 1980).

63. Etheostoma maculatum vulneratum (Cope) - spotted darter. Taken only in the upper portion of the main river, this darter prefers riffles with swift current, usually over a gravel or cobble substrate. Specimens were also collected in vegetation along the shoreline.

Although presently recognized as a subspecies of E. maculatum, the status of this and other populations of the spotted darter are under study by Dr. D. A. Etnier, who indicates that full species recognition for each of the three recognized subspecies may be in order. Stations: 2,16,21-23.

64. Etheostoma rufilineatum (Cope) - redline darter. Abundant throughout the North Fork system, in riffles with moderate to fast current over a variety of substrates. Stations: 1-19,21-34.

65. Etheostoma simotum (Cope) - Tennessee snubnose darter. Found throughout the North Fork system, usually in sluggish pools. Stations: 1-19,21-34.

66. Etheostoma zonale (Cope) - banded darter. Common throughout the main river, but rare in tributaries. Banded darters were usually associated with riffles of moderate current over sand and/or gravel substrate, especially in areas with emergent vegetation. Stations: 1-4,6-7,9,11-13,15-16,18,23-26,29-30.

67. Percina aurantiaca (Cope) - tangerine darter. This large darter is common to abundant in the main river, where it inhabits a variety of habitats from pools with boulder, large rubble, and/or bedrock substrate to riffles of moderate current with sand and gravel substrate. It is listed as of special concern in Virginia (Jenkins and Musick 1980) and in need of management in Tennessee (Starnes and Etnier 1980). Stations: 1-4,6,8,10,14-15,17,19,21,23.

68. Percina burtoni Fowler - blotchside logperch. There appears to be a good population of this scarce darter at RM 91.4, where it is usually found at the head of a pool over bedrock, boulder, and rubble substrate. A single specimen was also collected at RM 76.6, and five were collected from Laurel Creek in similar habitats. Listed as of special concern in Virginia (Jenkins and Musick 1980). Stations: 18,23,33.

69. Percina caprodes caprodes (Rafinesque) - logperch. The logperch is not common in the North Fork system, being taken only in small numbers at a few localities above RM 72.0. They are usually found in riffles over a gravel substrate. Stations: 16,21-23.

70. Percina evides (Jordan and Copeland) - gilt darter. Preference for a specific stream size is illustrated by this darter, which occurs in high numbers in the main river up to RM 76.5, but does not occur upstream or in any tributaries. It is usually found in riffles over a sand and gravel substrate. Stations: 1-4,6-7,10-13,15-16,18.

71. Percina macrocephala (Cope) - longhead darter. This rare percid was collected at three localities in the main river, from RM 6.3 to RM 91.4. It was usually associated with deep pools over varying substrate of boulders, bedrock, sand and gravel. It is listed as of special concern in Virginia (Jenkins and Musick 1980). Stations: 4,22-23.

72. Cottus baileyi Robins - black sculpin. This species, which is restricted to several upper Tennessee River tributaries, was taken at two sites: RM 76.6 and Lick Creek. These specimens were recently reidentified by R. E. Jenkins as this species. Other collections of C. baileyi have been taken, all well above Saltville (R. E. Jenkins, pers. comm.). Reports of Cottus bairdi Girard from the North Fork are probably based on this species, since C. bairdi does not occur in the system (R. E. Jenkins, pers. comm.). Stations: 18,34.

73. Cottus carolinae (Gill) - banded sculpin. The banded sculpin was taken throughout the drainage in small numbers, usually in association with a rubble or gravel substrate. Stations: all.

Discussion

The North Fork of the Holston River has a history of pollution from a large Olin Corporation chlor-alkali plant located in Saltville, VA (RM 82.0), which began operation in 1894. Fish samples taken in 1971 indicated generally small population sizes, although diversity was comparable to adjacent streams of similar size. It appears that heavy releases of dissolved solids (sodium and chloride wastes) were primarily responsible for these low fish populations (Hill et al. 1975, Neves

1983). The plant was closed in 1972, and since then there has been a steady recovery of the fish fauna, with 1983 samples showing the greatest numbers of individuals since sampling was initiated. One species that has shown exceptional recovery is the smallmouth bass, with individuals of all size classes being well represented in the samples.

Despite this significant recovery, it was found that fishes still retained excessively high concentrations of mercury in their bodies, which exceeded FDA limits for safe human consumption (Bailey 1974, Toole and Ruane 1976, Milligan and Ruane 1978). This led to a ban, by both Tennessee and Virginia, on consumption of fish taken from the North Fork. The source of this contamination was a disposal site remaining from the old Olin plant, from which there was a continual flow of mercury into the river and accumulation of mercury along the river bottom. Reclamation efforts were begun in August 1982. The stream was first diverted around the affected site. The substrate of the now-dry streambed was removed, the bottom scraped, and the site was cleaned via high-pressure applications of water. Following this the stream bottom was sealed with concrete and covered with fresh substrate, after which the stream was redirected back into the old channel. Samples taken by Olin biologists shortly after renovation indicated numbers of fishes to be nearly comparable to those prior to renovation (M. Smithson, pers. comm.). The biologists also found evidence of insect colonization. However, it is still too soon to judge how effective this action has been in eliminating mercury seepage and the resultant uptake by fishes.

Our collections, along with others (totaling over 200), show the North Fork Holston River system to have a fish faunal diversity typical of most upper Tennessee River tributaries. A total of 73 species, representing 11 families, is known from the system, of which all but eight species were taken in our samples. Based on the large number of collections and intensity of sampling efforts, I feel this is an accurate indication of the system's present faunal composition.

Additional species not included in the above annotated list have been reported from the North Fork system by earlier workers. Masnik (1974) summarized these from the literature. Of these, the harelip sucker (Lagochila lacera Jordan and Brayton), which was reported by Jordan (1889), is now extinct throughout its entire range (Jenkins 1980). The yellowfin madtom (Noturus flavipinnis Taylor) was collected just above Saltville, Virginia, by Jordan in 1888 (RM 82.0), who indicated it to be "not rare" (Jordan 1889). It still occurs in the neighboring Clinch River system (Taylor et al 1971), but no additional individuals have been taken in the North Fork. Cope (1868) reported a gar (Lepisosteus huronensis Richardson), which was based on a head found along the river near Saltville. The species in question almost certainly was the longnose gar (Lepisosteus osseus (Linnaeus)), which may still occur in the main river in small numbers; however, since no specimens have been collected from this area in over 100 years, I have not included it in my list. Records for the blackside darter (Percina maculata (Girard)) and orangethroat darter (Etheostoma spectabile (Agassiz)), which emanate from an early collection by H. R. Becker, almost certainly are the result of transposition of locality data (R. E. Jenkins, pers. comm.). Reported occurrence of the mirror shiner (Notropis spectrunculus (Cope)) is plausible (this species is known from the Middle and South Fork systems), but more likely is based on the closely related sawfin shiner (Notropis new species). Records of Cottus bairdi from the North Fork system were earlier discussed in the account of C. baileyi.

The above discussion serves to introduce the point that certain species present (and sometimes common) in the adjacent Middle and/or South forks of the Holston are apparently absent from the North Fork. These include (together with the systems in which they are present) the river redbhorse (Moxostoma carinatum (Cope)) (Middle and South forks), blotched chub (Hybopsis insignis Hubbs and Crowe) (South Fork), mirror shiner (Notropis spectrunculus) (Middle and South forks),

fatlips minnow (Phenacobius crassilabrum Minckley and Craddock) (South Fork), longnose dace (Rhinichthys cataractae (Valenciennes)) (South Fork), Swannanoa darter (Etheostoma swannanoa Jordan and Evermann) (Middle and South forks), and broadband sculpin (Cottus sp. cf. carolinae) (Middle and South forks). According to R. E. Jenkins (pers. comm.), waters of the North Fork system tend to be slightly warmer, on the average, than those of either the Middle or South fork systems. This factor may be involved in the absence of some of the above species from the North Fork area, since ranges of the last five species in the Tennessee River drainage are largely confined to the cooler upland streams of North Carolina.

The occurrence and/or abundance in the North Fork system of several species of Notropis (N. spilopterus, N. volucellus, N. ardens) are puzzling. Notropis spilopterus, which is common to abundant in downstream sections of the main Holston River and in the adjacent Clinch and Powell rivers, is rarely taken in the North Fork. Although found at scattered localities from RM 4.8 to RM 53.6, collections usually consisted of one or a few specimens. Since stream size does not appear to be the primary factor affecting distribution of this species, its reduced abundance in the North Fork may result from competition with other species of Notropis. Notropis volucellus, which is common in the Clinch and Powell rivers, is scarce in the North Fork, and it appears that only a small relict population still exists in this system. It is tempting to speculate that this may somehow be related to presence of a large population of the morphologically similar sawfin shiner (Notropis sp.), although it should be noted that these species occur sympatrically in moderate numbers in the Clinch and Powell rivers. The occurrence of Notropis ardens in the North Fork is also peculiar. This species has a spotty distribution in the main Holston River system, and is only known from the North Fork from a single sample from Possum Creek. A 1976 rotenone collection by us from the same area did not include this species.

For some unknown reason the population of Hybopsis monacha in the North Fork system appeared to be declining during the mid-1970's. However, recent underwater observations by R. E. Jenkins, N. M. Burkhead, and TVA personnel have shown an increase in numbers, and in addition the species has recently been discovered at several new localities (Jenkins and Burkhead 1984). These fluctuations may be attributable to several factors: (a) H. monacha may always have normally had large population fluctuations in this area, (b) some environmentally limiting factor(s) has (have) been eliminated; and/or (c) the species has experienced exceptional reproductive success in recent years. The most upstream occurrence of H. monacha is above Saltville, at RM 88.6 (specimens taken in 1954 by a crew from the Academy of Natural Sciences of Philadelphia), but this upstream population appears to have been extirpated. It was earlier reported as "rare" or "scarce" by Cope (1868) and Jordan (1889), respectively, in the vicinity of Saltville (RM 81). However, it was not taken above RM 23.4 between 1954 and 1981, after which Burkhead and Jenkins began to find new localities upstream to ca. RM 54. At present, this species apparently is doing well in parts of the lower half of the North Fork system.

A unique relationship exists between the three species of Noturus found in the North Fork system. Noturus eleutherus was taken in large numbers in lower sections of the main river upstream to RM 18.1, whereas N. insignis was only taken above RM 72.0. These two species were not collected at any locality in the North Fork system, but the downstream range limit of N. insignis (now at RM 72.0) has increased since sampling was begun in 1971. The two species may eventually become syntopic in the system. Noturus flavus is restricted to tributaries and does not occur with either of the other two species.

Ross and Carico (1963) considered the occurrence of N. insignis in the North Fork to result from stream piracy of the New River around Burke's Garden, Virginia. Both Taylor (1969) and I are inclined to attribute the occurrence of the species in this area to bait-fish in-

roduction, for the following reasons: (a) madtoms are popular bait fish, and *N. insignis* is readily available in the adjacent New River drainage; (b) *N. insignis* was absent from early collections from the area (the earliest were made in 1951 by E. C. Raney); and (c) this species appears to be expanding its range in the North Fork system (our collections over the past 15 years clearly indicate dispersal downstream).

Acknowledgments

I would like to thank Dr. Robert E. Jenkins for his assistance in all aspects of this manuscript. He provided valuable collection records, made suggestions, and reviewed the paper. I would also like to thank Drs. D. A. Etnier and M. Keene for their review of the manuscript. The names of all the TVA personnel who participated in the fieldwork during this project are too numerous to mention, but all are gratefully acknowledged. Charles Saylor helped with the identification of fish specimens.

Literature Cited

- Bailey, D. S. 1974. The occurrence of mercury in the fish and sediment of the North Fork of the Holston River 1970-1972. Va. St. Water Control Bd. Basic Data Bull. 41. 62 pp.
- Cope, E. D. 1868. On the distribution of freshwater fishes in the Allegheny region of southwestern Virginia. J. Acad. Nat. Sci. Phila. (Ser. 2), 6: 207-247.
- Feeman, J. 1980. A quantitative survey of fish and macroinvertebrates of the Holston River basin: August-September 1973. Report No. WR (70) 40-4-80.1 Tenn. Valley Auth., Norris, TN. 38 pp.
- Gilbert, C. R. 1969. Systematics and distribution of the American cyprinid fishes *Notropis ariommus* and *Notropis telescopus*. Copeia 1969(3): 474-492.
- Hickman, G. D. and C. F. Saylor. 1984. Snorkeling and scuba diving, pp. (5-1)-(5-8), in warmwater streams techniques manual. Warmwater Streams Committee, Southeastern Div., Amer. Fish. Soc.
- Hill, D. M., E. A. Taylor and C. F. Saylor. 1975. Status of faunal recovery in the North Fork Holston River, Tennessee and Virginia. Proc. 28th Ann. Conf. Southeast. Associ. Game and Fish Comm. (1974): 398-413.
- Hubbs, C. L. and M. B. Trautman. 1937. A revision of the lamprey genus *Ichthyomyzon*. Misc. Publ. Mus. Zool. Univ. Mich. 35: 1-109.
- Jenkins, R. E. 1980. *Iagochila lacera* Jordan and Brayton, harelip sucker. p. 407 in D. S. Lee, et al. Atlas of North American Freshwater Fishes. N.C. State Mus. Nat. Hist., Raleigh, i-x + 854 pp.
- and N. M. Burkhead. 1984. Description, biology, and distribution of the spotfin chub (*Hybopsis monacha*), a threatened cyprinid fish of the Tennessee River drainage. Bull. Ala. Mus. Nat. Hist. 8: 1-30.
- and J. A. Musick. 1980. Freshwater and marine fishes. Pp. 319-374 in D. W. Linzey, ed., Endangered and threatened plants and animals of Virginia. Va Polytechnic Inst. and St. Univ.
- Jordan, D. S. 1889. Report of explorations made during the summer and autumn of 1888, in the Allegheny region of Virginia, North Carolina and Tennessee, and in western Indiana, with an account of the fishes found in each of the river basins of those areas. Bull. U.S. Fish Comm. (1888) 8: 97-173.
- LeGrande, W. H. and T. M. Cavender. 1980. The chromosome complement of the stonecat madtom, *Noturus flavus* (Siluriformes: Ictaluridae), with evidence for the existence of a possible chromosomal race. Copeia 1980(2): 341-344.
- Masnik, M. T. 1974. Composition, longitudinal distribution, and zoogeography of the fish fauna of the upper Clinch system in Tennessee and Virginia. Ph.D. disser., Va. Polytechnic Inst. and St. Univ., Blacksburg, Va. 401 pp.
- Milligan, J. D. and R. J. Ruane. 1978. Analysis of mercury data collected from the North Fork of the Holston River. Tenn. Valley Auth., Chattanooga, TVA/EP-78/12. 33 pp.
- Neves, R. J. 1983. Recovery plan for Fine-rayed pigtoe pearly mussel, *Fusconaia cuneolus*. Draft recovery plan for U.S. Fish and Wildlife Service, Region 4, Atlanta, Ga. 64 pp.
- Patrick, R. 1961. A study of the numbers and kinds of species found in rivers in eastern United States. Proc. Acad. Nat. Sci. Phila. 113: 215-258.
- Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada (4th ed.). Amer. Fish. Soc. Spec. Publ. 12. 174 pp.
- Ross, R. D. and J. E. Carico. 1963. Records and distribution problems of fishes of the North, Middle, and South forks of the Holston River, Virginia. VA. Agr. Exp. Sta. Tech. Bull. 161. 23 pp.
- Starnes, W. C. and D. A. Etnier. 1980. Fishes. Pp. B-1 to B-134 in D. C. Eager and R. M. Hatcher. Tennessee's rare wildlife. Vol. I: The vertebrates. Tenn. Wildl. Resour. Agency, Nashville.
- Taylor, W. R. 1969. A revision of the catfish genus *Noturus Rafinesque* with an analysis of higher groups in the Ictaluridae. Bull. U.S. Nat. Mus. 282: 1-315.
- Toole, T. W. and R. J. Ruane. 1976. Evaluation of the mercury monitoring program, the North Fork Holston River. Tenn. Valley Auth., Chattanooga. E-WQ-76-2. 33 pp.