1979

Freshwater and Marine Fishes

Robert E. Jenkins

ENDANGERED AND THREATENED PLANTS AND ANIMALS OF VIRGINIA

Donald W. Linzey, Editor

Proceedings of the Symposium

on

ENDANGERED AND THREATENED PLANTS AND ANIMALS OF VIRGINIA

held at

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Blacksburg, Virginia

May 19 - 20, 1978

Donald W. Linzey, Editor

Sponsored by

CENTER FOR ENVIRONMENTAL STUDIES
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

1979

Funds for Preparation of Camera-ready Copy Provided by Extension Division
Sea Grant Program, Virginia Polytechnic Institute and State University (VPI-SG-79-13)
and by the Virginia Chapter, Nature Conservancy

Funds for Printing
Were Provided by the Extension Division
Virginia Polytechnic Institute and State University

TABLE OF CONTENTS

FRESHWATER AND MARINE FISHES[1]

Robert E. Jenkins

Introduction

Robert E. Jenkins and John A. Musick

The current list of freshwater fishes known from Virginia stands at 206 species, including 10 that are diadromous and 4 others ranked as freshwater-estuarine. Eight of the freshwater and one of the freshwater-estuarine species were introduced to the state. Several additional strictly freshwater fishes are expected to be discovered. The Virginia freshwater ichthyofauna is relatively rich in species compared with most other states. For example, Maryland and Delaware together have 99 species (Lee *et al.*, 1976), West Virginia 151 (Denoncourt *et al.*, 1975), Kentucky 201 (Clay, 1975), and North Carolina 195 (Menhinick *et al.*, 1974). Some of these totals reflect our adjustments for diadromous and estuarine fishes. The other adjacent state, Tennessee has a much richer freshwater fauna than Virginia.

The high number of freshwater species in Virginia relates to habitat diversity within, and major ecological differences between, the five physiographic provinces (Hoffman, 1969) drained within the state. Also involved are prehistoric evolutionary factors such as geographic isolation and speciation following penetration by fish stocks of drainage divides via stream captures and other drainage modifications (Ross, 1969; 1972a; Lachner and Jenkins, 1971; Jenkins *et al.*, 1972). The fauna basically are adapted to running water, with most species preferring clear, clean water and a bottom not heavily silted. There are only two natural lakes in Virginia, at altitudinal extremes -- Mountain Lake in Giles County and Lake Drummond, the latter in Dismal Swamp.

Of the 197 native freshwater species, 3 are considered herein as *Endangered*, 6 *Threatened*, and 25 are so restricted in distribution and/or so rare in Virginia that they are listed as of *Special Concern*. The total of 34 represents 17% of the native freshwater fish fauna. Additionally, one of the 197 species is completely *Extinct*, another is *Extirpated* from the state, and a third has one of its subspecies *Extirpated* from the state. Five other species are of *Undetermined Status*, and at least one of these probably is *Extirpated*.

The freshwater ichthyofauna as a whole are impacted by a number of factors adverse to survival of fishes. Major factors include excessive turbidity and silt loads, domestic and chemical pollution, channel modification, disruption of natural temperature regimen, reduction of instream flow, impoundment, and competitive species interactions (in one case following introduction of a non-native fish species). Often it is difficult to identify the specific factor(s) that have reduced or extirpated populations, as did P. W. Smith (1971) for Illinois fishes, and Trautman and Gartman (1974) in Ohio. Some of the problems, particularly siltation, are widespread, chronic and/or continual. Specific perturbatory factors are noted

[1] Contribution Number 867 from the Virginia Institute of Marine Science.

in the accounts for many species. For some species only one life stage, or reproduction, may be affected, whereas with other species effects may be general and even cumulative throughout the life cycle. In any case, the results may be the same - reduction or elimination of populations.

Virginia's marine and estuarine fish fauna is characterized by its dynamic nature. Most elements of the fauna are migratory. All are highly mobile. Most are widespread coastally and occur in their preferred habitats in many localities within Virginia and other states. Musick (1972) annotated 208 species of marine and estuarine fishes within Virginia's coastal fish fauna, including 174 marine, 24 estuarine, and 10 diadromous (9 anadromous, 1 catadromous) species. Fourteen (10 diadromous and 4 estuarine) species are shared with the freshwater faunal list. Of the 174 marine species, 59 are regular summer visitors and 93 occur rarely or sporadically during the summer. During the winter only 6 marine fishes are regular visitors and 16 occur rarely or sporadically. All of the 24 species of estuarine fishes are resident. These along with 3 anadromous, 1 catadromous, and 2 marine species remain in shallow coastal habitats in Virginia during the entire year.

From the foregoing it appears that there are many species which may occur rarely and/or seasonally in Virginia's coastal waters. It would be ridiculous to include most of these on a list of endangered species for the state because they are extralimital for the most part, and are able to visit Virginia occasionally because of their mobility and the inherent accessibility of the marine environment. We recognize only three species of marine or estuarine inhabitants for inclusion within the list of Virginia threatened and endangered biota. These are two anadromous fishes, the shortnose sturgeon *(Acipenser brevirostrum)* as *Endangered*, Atlantic sturgeon *(Acipenser oxyrhynchus)* as *Threatened*, and an estuarine fish, the marsh killifish *(Fundulus confluentis)* as of *Special Concern*. The two sturgeons are included in totals and the percentage of freshwater fishes; the killifish is excluded from the most recent freshwater faunal list.

Some of the problems that beset certain marine and estuarine fishes are dredging, thermal pollution, chemical pollution including oil spills and spraying for insects, alteration of marshes to drier habitats, and overfishing of commercially important species.

Data Sources and Acknowledgments

Although some significant areas of the Old Dominion remain to be explored ichthyologically, its waters generally have been well surveyed qualitatively -- the result of more than a century of accumulated efforts. Quantitative studies have been made of several streams and estuaries. Hildebrand and Schroeder (1928) and Musick (1972) documented, including extensive references, results of collections of marine and estuarine fishes. The locations of some 4100 freshwater and estuarine collections are shown in Jenkins *et al.* (1976) and about 1300 additional recent freshwater collections are encompassed in the present report. Some of the earlier history of Virginia freshwater ichthyology is noted in Jenkins *et al.* (1976). Unfortunately, few collections were made prior to 1940. The most significant forays were in 1867 by Cope (1868), in 1888 by Jordan (1889), and in 1937 and 1938 by Schultz (1939). Many elements of the fauna probably were declining during that period. From 1940, starting with extensive efforts by E. C. Raney and his students, a good, wide data base was established and it has been synthesized by the first author. Jenkins *et al.* (1972: particularly page 57) cited extensive distributional literature not directly treated herein.

For the privilege of study of collections, aid or information we are most grateful to a host of ichthyologists. These include: R. M. Bailey and R. R. Miller, University of Michigan; R. I. Bonn and L. H. Robinson, Soil Conservation Service; R. S. Birdsong, Old Dominion University; R. D. Estes, Tennessee Tech University; D. A. Etnier and N. M. Burkhead, University of Tennessee; J. C. Feeman, R. B. Fitz and C. F. Saylor, Tennessee Valley Authority; E. D. Frankensteen, U.S. Army Corps of Engineers; W. M. Howell, Samford University; J. E. Johnson and R. J. Reed, University of Massachusetts; D. P. Kelso, George Mason University; E. F. Menhinick, University of North Carolina at Charlotte; B. S. Kinnear, National Marine Fisheries Service; E. A. Lachner and S. Karnella, National Museum of Natural History, Smithsonian Institution; J. Loesch, Virginia Institute of Marine Science; L. O. Mohn, P. Bugas, D. A. Griffin, M. D. Norman, D. K. Whitehurst, and R. E. Wollitz, Virginia Commission of Game and Inland Fisheries; E. C. Raney, formerly Cornell University; J. R. Reed, formerly Virginia Commonwealth University; R. D. Ross, formerly Virginia Polytechnic Institute and State University, and former students P. S. Hambrick, C. H. Hocutt, M. T. Masnik and J. R. Stauffer; M. E. Seehorn and P. A. Shrauder, U.S. Forest Service; J. P. Oland and J. R. Sheridan, U.S. Fish and Wildlife Service; W. B. Smith, North Carolina Wildlife Resources Commission; R. D. Suttkus, Tulane University, and former students R. C. Cashner, J. S. Ramsey and B. A. Thompson; L. N. Chao, D. F. Markle and C. A. Wenner, formerly Virginia Institute of Marine Science; S. L. Whitt, Lynchburg College; W. S. Woolcott, University of Richmond and Virginia Institute of Scientific Research; and T. Zorach, Wells College.

This study has been supported by the Virginia Commission of Game and Inland Fisheries and with studies made by the first author for the Office of Endangered Species and International Activities of the U.S. Fish and Wildlife Service, the Annapolis Field Office of the U.S. Fish and Wildlife Service, and the Wilmington District of the U.S. Army Corps of Engineers. In the latter three offices, respectively, we particularly thank J. D. Williams, J. P. Oland, and E. D. Frankensteen for their coordination of the studies.

We are particularly indebted to the other members of the Committee on Fishes for their input to our analysis of the Virginia fauna: R. S. Birdsong, D. A. Etnier, C. H. Hocutt, D. P. Kelso, R. T. Lackey (Virginia Polytechnic Institute and State University), G. F. Martel (Virginia Commission of Game and Inland Fisheries), E. F. Menhinick, and W. S. Woolcott.

Abbreviations used herein:

CU-Cornell University
USNM-National Museum of Natural History
VIMS-Virginia Institute of Marine Science
VPI&SU-Virginia Polytechnic Institute and State University

SL-standard length
FL-fork length
TL-total length

In this report we have attempted to use the following terms in a consistent sense, as defined (in part, Jenkins *et al.*, 1972):

System - a main channel and its tributaries forming a subdivision of a drainage.

Drainage - an interconnected major group of streams or systems entering an Atlantic estuary (*e.g.*, James River drainage) or the Ohio River (such as the Tennessee River drainage).

Stream size:

Creek - watercourse which averages up to about 10 meters in width.

Stream (when used in strict sense herein) - average between 10 and 60 meters in width.

River - usually greater than 60 meters average width.

Previous Lists and Concepts of Status Categories

Seven freshwater species (roughhead shiner, bigeye jumprock, rustyside sucker, yellowfin madtom, orangefin madtom, blotchside logperch, and Roanoke logperch) were regarded as *Rare* in Virginia (and nationally) by Jenkins (*In:* Miller, 1972). The sense of the *Rare* category was roughly synonymous with that of *Threatened* as used herein and federally. In 1974, seven species (as above, except roughhead shiner and bigeye jumprock deleted due to new information; duskytail darter and sharphead darter added - the sharphead just discovered in Virginia) were listed as *Endangered* in Virginia (Anonymous, 1974b). Actually, the *Threatened* category, to which most of the species were then assigned by Jenkins, was merged with *Endangered* by the editor of that paper.

One of the most important events regarding recognition of species in jeopardy was the workshop sponsored by the Southeastern Division of The Wildlife Society that was held in September 1974 in Tallahassee, Florida. The sessions treating southeastern freshwater fishes were chaired by C. R. Gilbert and had vast input from some 15 southeastern ichthyologists in attendance who were thoroughly familiar with the fish fauna of their state of residence and other states. Hence, each species could be considered validly on a southeastern regional and national basis. All but one of the freshwater fishes regarded herein as *Endangered* or *Threatened* were recommended for enlistment on a national basis under one of these categories. The categories essentially were as defined and currently used for federal status.

The Committee on Fishes for the present work encountered some difficulty with application on a state level of certain categories used herein. For all species we considered total distribution and abundance extralimital to Virginia. Although we feel that the large majority of species are properly ranked with regard to state political boundaries, some species listed as both *Special Concern* and "peripheral" in the table and accounts may actually merit *Threatened* or *Endangered* status with respect to the Virginia population only. Good examples are the four species listed from the Peedee River drainage, which drains only a very small portion of Virginia, the pearl dace and slimy sculpin of the Potomac-Shenandoah River drainage, the sand shiner on the state line in the New River drainage, and some of the Tennessee River drainage fishes. Eighteen of the 26 fishes listed as *Special Concern* are considered peripheral. None of the populations of the *Endangered* or *Threatened* species are considered peripheral (Table 1).

The lack of comprehensive knowledge of distribution and abundance of freshwater fishes in Virginia during settlement and later historical periods hampers our thinking of ecological tolerances, present status, and projected future success of species. A number of species, for example the orangefin madtom and Roanoke logperch in the Roanoke drainage and the spotfin chub and yellowfin madtom of the Tennessee drainage, have been known since their discovery to occupy only a single small portion of, and/or have disjunctive ranges within, the physiographic province sections of drainages that include their preferred habitat. For some species we can document recent depletion or extirpation of populations caused by man, but for many it is not clear whether disjunction has been of long term and due to natural factors, or of recent origin relating to man-caused changes. We suspect that many cases of apparent but undocumented extirpation arose from a widespread increase in turbidity and siltation, particularly during the 1800's, associated with settlement and deforestation. Among the numerous nonpoint factors causing stream degradation, turbidity and siltation probably have been the most widely destructive to native aquatic life. One may conclude that many or all extant populations of numerous species given status herein are existing in marginal habitat conditions, are barely surviving, and that only a slight decline in stream quality could cause their extirpation. If this is true, then the status of many species could be downgraded from *Special Concern* to *Threatened* or *Endangered*.

Fishes and other aquatic organisms have preferred habitats and ecological niches, described by parameters such as type and availability of food, stream gradient, current velocity, bottom type, water temperature and chemistry, depth, cover and other factors. Many, and in some watersheds all, of these factors vary with distance from the shoreline in standing or lentic waters such as ponds and lakes, and from source springs in running or lotic waters, effecting specific zonal distribution patterns of the biota. Hence, most species of fishes of running water may be classified as small creek, or stream, or riverine forms, regardless of the specific (often unidentified) factor(s) that establish and enforce the zonal patterns. Linear or longitudinal zonation patterns have been discussed broadly by Hynes (1970) and were determined for the fishes of several Virginia streams (Burton and Odum, 1945; Jenkins and Freeman, 1972; Jenkins and Burkhead, 1973; Hambrick, 1973; Masnik, 1974; Stauffer *et al.*, 1975). Jenkins *et al.* (1972) ranked central eastern United States freshwater fishes according to their habitation of creeks, streams, or rivers (and with respect to gradient).

Recognition of linear zonation is important with regard to environmental problems. The large majority of the species listed herein prefer or are restricted to moderate and large size streams and rivers, even though the fishes may be small in size. Larger streams and rivers generally are more developed and adversely impacted from point and nonpoint sources than small streams because they provide sufficient water supply for population centers and industry. Although a moderate to relatively large number of records exist for some riverine species listed herein, the records are concentrated in or confined to a few main channels -- for some species only one or two rivers. If sufficiently stressed at one upstream point, populations inhabiting a considerable length of river could be extirpated. Some of the records of typically riverine species are from the lower sections of major tributaries, suggesting a source for natural restocking of the main river after fish kills. However, tributary populations of some riverine fishes actually may be unstable, reliant upon recruitment from the main river, and insignificant to recovery of the river fauna to its former diversity. In fact, tributary populations may die out with demise of the river population (for a possible example, see account of Tippecanoe darter). Rapid recovery in the river of more tolerant or fecund species may preclude, by competitive interaction, reestablishment of sensitive or less fecund forms.

Although larger streams have greater capacity to dilute pollution, a general rule seems to exist in upland and montane regions of Virginia concerning many sensitive species: the larger the size of streams to which they are restricted or that they prefer (and the fewer the number of streams or "threads of life" they occupy), the greater is the jeopardy in which the species is placed. Partial resolution of this apparent enigma may relate to greater depositional tendencies in larger streams, which course through larger valleys, have moderate to low gradients in Virginia, and hence are generally subject to greater rates of siltation than smaller, higher gradient, dominantly erosional tributaries on slopes. We therefore think that amounts of pollution, siltation, and stream size preferences all are interrelated with degree of environmental stress on species.

We are also concerned with attrition in quality of small streams. While there are many more small than large streams in Virginia, and deterioration of small streams often is a more localized and perhaps alleviable problem, redispersal of extirpated headwater species via larger channels may be impeded or prevented by natural ecological barriers and by other factors such as dams and pollution.

TABLE 1

List of fish species whose Virginia population(s) is recommended for one of the following status categories: Endangered (E), Threatened (T), Special Concern (SC), Extinct or Extirpated (X). Peripheral (P) is appended for certain species of Special Concern whose Virginia population currently is not critical to the overall survival of the species.

	FAMILY: ACIPENSERIDAE	
E	*Acipenser brevirostrum*, Shortnose sturgeon	Anadromous
T	*Acipenser oxyrhynchus*, Atlantic sturgeon	Anadromous
	FAMILY: POLYODONTIDAE	
SC(P)	*Polyodon spathula*, Paddlefish	Clinch
	FAMILY: CYPRINIDAE	
SC(P)	*Hybopsis hypsinotus*, Highback chub	Peedee
SC(P)	*Hybopsis labrosa*, Thicklip chub	Peedee
E	*Hybopsis monacha*, Spotfin chub	N Holston
SC(P)	*Notropis ariommus*, Popeye shiner	N Holston, Clinch, Powell
SC(P)	*Notropis atherinoides*, Emerald shiner	Clinch, Powell
SC	*Notropis semperasper*, Roughhead shiner	James
SC(P)	*Notropis stramineus*, Sand shiner	New
SC(P)	*Notropis whipplei*, Steelcolor shiner	Clinch
SC(P)	*Phenacobius crassilabrum*, Fatlips minnow	S Holston
SC(P)	*Semotilus margarita*, Pearl dace	Potomac
	FAMILY: CATOSTOMIDAE	
X	*Lagochila lacera*, Harelip sucker	N Holston
SC(P)	*Moxostoma carinatum*, River redhorse	S & Mid Holston,Clinch,Powell
SC	*Moxostoma hamiltoni*, Rustyside sucker	Dan
SC(P)	*Moxostoma robustum*, Smallfin redhorse	Peedee
	FAMILY: ICTALURIDAE	
T	*Noturus flavipinnis*, Yellowfin madtom	N Holston, Clinch
T	*Noturus gilberti*, Orangefin madtom	James, Roanoke, Dan
	FAMILY: CYPRINODONTIDAE	
SC(P)	*Fundulus confluentis*, Marsh killifish	Estuarine
	FAMILY: ATHERINIDAE	
SC(P)	*Labidesthes sicculus*, Brook silverside	Clinch, Powell
	FAMILY: PERCOPSIDAE	
X	*Percopsis omiscomaycus*, Trout-perch	Potomac
	FAMILY: COTTIDAE	
SC(P)	*Cottus cognatus*, Slimy sculpin	Potomac
	FAMILY: CENTRARCHIDAE	
SC	*Ambloplites cavifrons*, Roanoke bass	Chowan, Dan, Roanoke
SC	*Enneacanthus chaetodon*, Black-banded sunfish	Chowan

(continued)

	FAMILY: PERCIDAE	
E	*Etheostoma acuticeps*, Sharphead darter	S Holston
SC(P)	*Etheostoma camurum*, Bluebreast darter	N Holston, Clinch
SC(P)	*Etheostoma chlorobranchium*, Greenfin darter	S Holston
SC(P)	*Etheostoma jessiae*, Blueside darter	N Holston
T	*Etheostoma tippecanoe*, Tippecanoe darter	Clinch
T	*Etheostoma species*, Duskytail darter	Clinch
SC	*Percina aurantiaca*, Tangerine darter	N Holston, Clinch, Powell
SC	*Percina burtoni*, Blotchside logperch	N Holston, Clinch
X	*Percina caprodes semifasciata*, Northern logperch	Potomac
SC	*Percina copelandi*, Channel darter	Clinch, Powell
SC(P)	*Percina crassa*, Piedmont darter	Peedee
SC	*Percina macrocephala*, Longhead darter	Mid & N Holston, Clinch
T	*Percina rex*, Roanoke logperch	Chowan, Roanoke, Dan

Critical Watersheds and Habitats

The following is a consideration of specific streams, stream systems, or habitat types that collectively sustain all freshwater species recommended herein for status of *Endangered* and *Threatened* and for most species listed as *Special Concern*. Hence, the watersheds merit particular attention regarding conservation of Virginia's fish fauna (Figure 1; Table 2). Federal designation of some of the streams as Critical Habitat is noted.

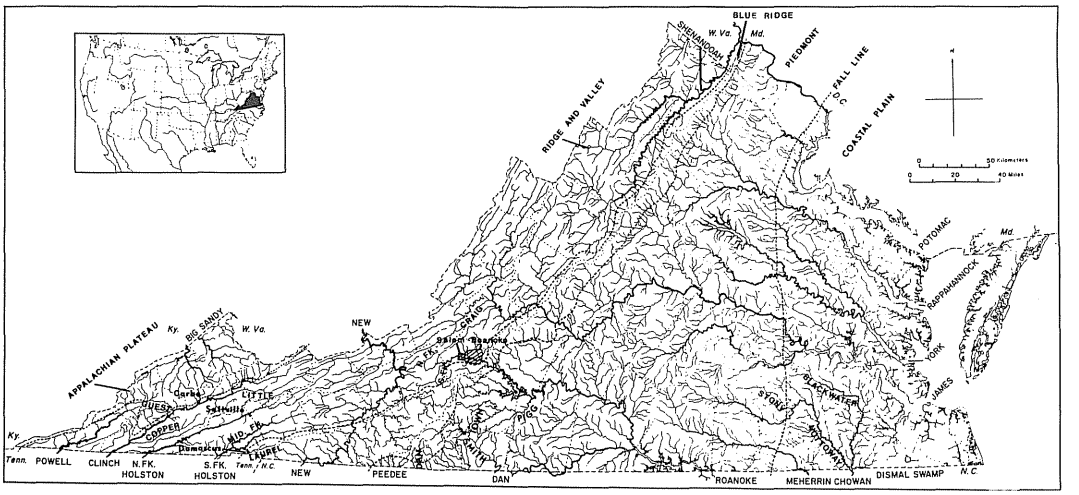


Figure 1. Principal streams, rivers, physiographic provinces and certain towns and cities

TABLE 2

Summary of critical drainages or subdivisions supporting jeopardized surviving populations of fish species in Virginia. Sequence of listing of watercourses is first on the Atlantic slope from north to south, then in Ohio River basin from east to west and then south to north (clockwise).

	Status of Species in Virginia			
	Endangered	*Threatened*	*Special Concern*	Total
Potomac-Shenandoah River drainage	-	-	2	2
Upper James River drainage	-	1*	1	2
Blackwater River, Chowan River system	-	-	1	1
Stony Creek, Nottoway River system	-	1	1	2
Upper Roanoke River system**	-	2	1	3
Town Creek, Dan River system	-	1	1	2
Upper Dan River system, Patrick County	-	1	1	2
Peedee River drainage	-	-	4	4
New River drainage	-	-	1	1
South Fork Holston River	1	-	2	3
Laurel Creek, South Fork Holston system	-	-	2	2
Middle Fork Holston River	-	-	2	2
North Fork Holston River	1	-	6	7
Clinch River***	-	1	11	12
Copper Creek, Clinch River system	-	3	6	9
Powell River	-	-	6	6
Anadromous	1	1	-	2
Estuarine	-	-	1	1

*refers to *Noturus gilberti*, possibly introduced.
**section above Leesville Dam.
***excludes two species of Clinch system in Virginia known to be surviving only in Copper Creek.

Fall Line

This is a roughly north-south oriented belt or zone of varying width, approximately 10-30 kilometers in Virginia, through which Atlantic slope streams have increased gradient in their descent from the gently undulating outer Piedmont onto the relatively flat Coastal Plain. The increments in gradient vary from high in the Potomac River (1.9 meters per kilometer or 10 feet per mile, through 28 kilometers or 17 miles, from Chain Bridge in Washington, D.C. to the mouth of Seneca Creek) to moderate in the Nottoway and Meherrin Rivers of the Chowan system (one meter per kilometer, Jenkins *et al.*, 1975). In the more northern drainages of Virginia, the Fall Line is characterized by frequent falls, cascades or rocky rapids, whereas in the Chowan major falls are absent, although riffles become more frequent and the substrate firmer than in the adjacent provinces.

The Fall Line passages of our rivers and smaller waterways are scenic and provide unique habitats for development of diverse fish faunas. For some anadromous species they provide spawning habitat. For many year-round resident fish populations they comprise ecotonal habitats supporting both Piedmont and Coastal Plain species, and often with an admixture of disjunct populations of characteristically montane and upper Piedmont forms, *e.g.*, the Roanoke logperch, *Percina rex*, in the Chowan system (Jenkins *et al.*, 1975).

Some of Virginia's larger cities have been built in or near the Fall Line -- Washington, D.C. and suburbs, Fredericksburg on the Rappahannock, and Richmond on the James. This relates to a large supply of fresh water and blockage by the Fall Line of major shipping. Industrial and domestic pollution associated with such population centers have led to degradation of adjacent riverine and estuarine habitats, reducing fish populations and recreational and other human uses of the rivers. Dam construction in some of these centers may have further reduced spawning habitat available to the two species of sturgeon, *Acipenser*, recommended for status herein, as well as that of other anadromous species such as shads and river herrings, *Alosa*.

Spring Runs of Potomac-Shenandoah Drainage

The larger cold springs and spring runs associated with limestone in the Potomac-Shenandoah Valley provide habitat for two Pleistocene glacial relicts, both of which reach their southern range limit therein -- pearl dace, *Semotilus margarita*, and slimy sculpin, *Cottus cognatus*. Most of these streams have suffered greatly, mainly by siltation from farm drainage and clearage of bank vegetation which also effected increasing temperature. One of the currently healthier streams, Mossy Creek in Augusta County, still supports both species and is only one of the two Virginia streams known to do so. It once had a probably native population of brook trout, but most of it has been heavily silted. It is now being developed into a specially regulated brown trout fishery (Schuder, 1977).

Upper Roanoke River Drainage

The Roanoke drainage of Virginia and North Carolina contains more fish species and has a greater number (6) of fish species or subspecies native and unique to a single drainage than any other drainage on the Atlantic slope of the United States (Jenkins *et al.*, 1972). The upper portion of the drainage, in the mountains and upper Piedmont of the Roanoke proper and Dan River systems, contains a major portion of the total Roanoke ichthyofauna, including all six forms endemic to the drainage.

The longest mileage of stream harboring more than one species recommended for status is Roanoke River and its North and South Forks in Roanoke and Montgomery counties, totalling some 88 kilometers (55 miles) starting in Roanoke River at the Tinker Creek mouth in the eastern sector of Roanoke. Some 62 kilometers (39 miles) remain with subtraction of the lower 26 kilometers of the river from eastern Roanoke

up to about the western limit of Salem. This lower section has been heavily stressed for many years (see *Percina rex* account), and the most sensitive species are absent or rare therein.

From Salem upstream the watershed harbors the apparently healthiest population of Roanoke logperch, *Percina rex*, and one of the most successful populations of orangefin madtom, *Noturus gilberti*. Action currently is underway at the federal level for designation of both species as *Threatened* and of the upper Roanoke as Critical Habitat. The section also contained one of the few known populations of Roanoke bass, *Ambloplites cavifrons*, until its demise in the 1950's , apparently owing to competitive exclusion by the introduced rock bass, *Ambloplites rupestris*. Additionally, the section supports virtually all other native species characteristic of the rich upper Roanoke fauna. Many elements of the fauna are jeopardized in the populous upper basin by effects of increasing urbanization, industrialization, and some of the proposals for flood control by channel modifications and dams.

Another upper Roanoke stream particularly worthy of mention is Town Creek, a major tributary of Smith River, Dan River system, Franklin and Henry counties. The Roanoke logperch and Roanoke bass were discovered in lower Town Creek in 1977, and its total fish fauna was found to be diverse. Maintenance of the apparently good water quality of the stream would protect the fauna. Town Creek is the largest tributary of the cold tailwater section of Smith River below Philpott Dam. This section of the Smith contains the finest larger stream trout fishery in Virginia, but it depends in good part on clean water from Town Creek.

Stony Creek, Lower Roanoke Drainage

This tributary of Nottoway River, Chowan River system, Dinwiddie and Sussex counties, sustains an isolated population of Roanoke logperch and additionally has the Roanoke bass. Much of the stream is considerably silted, although some stretches of firm gravel substrate occur in its lower half. A sewage treatment plant being located at the town of Stony Creek, about 1 kilometer above the mouth, may discharge wastes sufficiently chlorinated to distress the fauna. We note that the peculiar cutlips minnow, *Exoglossum maxillingua*, is nearly restricted in the Roanoke drainage to the upper Pigg River, Town Creek, and lower Stony Creek. These four waters also comprise all verified areas of occurrence of the Roanoke logperch. *Exoglossum maxillingua* is more widespread and often common in Atlantic slope drainages farther northward, but in the Roanoke it serves as an indicator of relatively good stream conditions, as do the three other above-mentioned Roanoke species.

South Fork Holston River System

This major branch of the Tennessee River drainage in Virginia has most of its tributaries arising in the Blue Ridge province. The main channel, although in the Ridge and Valley province, resembles moderately high gradient, cool Blue Ridge streams, and hence differs faunistically from the other major Tennessee drainage tributaries in the Virginia Ridge and Valley. The critical section of the South Holston system is the lower portion in Washington County above South Holston Reservoir. The main South Fork contains the sharphead darter, *Etheostoma acuticeps*, recommended for *Endangerd* status, and the fatlips minnow, *Phenacobius crassilabrum*, of *Special Concern*. Entering the South Fork a few kilometers above the single known *Etheostoma acuticeps* locality is its largest tributary, Laurel (or Whitetop Laurel) Creek. This stream contains clean, good trout water in its middle and upper reaches, but the lower section has been stressed by various effluents from the town of Damascus, and adverse effects have been detected in the South Fork below Laurel Creek. The only Virginia stream housing *Phenacobius crassilabrum*, besides the South Fork, is Laurel Creek, the record site being just above Damascus. Another species of

Special Concern, the greenfin darter, *Etheostoma chlorobranchium*, is known in the state from a single locality in Laurel Creek at a few kilometers above Damascus. Improvement of water quality in Laurel Creek would enhance the survival of those three species in Virginia; the effluent problems are being addressed (see *Etheostoma acuticeps* account).

North Fork Holston, Clinch and Powell Rivers

The fish fauna of the Tennessee River drainage probably is the richest of all North American drainage faunas (Jenkins *et al.*, 1972), and that of the Holston and Clinch-Powell systems (in part, Ross and Carico, 1963; Masnik, 1974) is among the most speciose within the drainage. The group composed of the North Fork Holston, Clinch and Powell rivers, all typical Ridge and Valley watercourses, has the largest number of surviving fish species (16) recommended for status. Additionally, the extinct harlip sucker occupied the North Fork and probably the Clinch and Powell. A number of other species have a distribution and/or abundance nearly as limited as that of some of the species listed as *Special Concern*. The Middle Fork Holston, a South Fork tributary, contains 2 of the 16 species (river redhorse, longhead darter). Only 1 of the 16 (river redhorse) also inhabits the South Fork Holston in Virginia. This is a partial expression of certain natural ichthyofaunal differences among the five main Tennessee River tributaries.

The North Fork Holston has been chronically stressed for many years by chemical effluents from industry in Saltville at the Smyth-Washington county line. This probably has been a major factor in the enlistment herein of eight main channel species: spotfin chub (*Threatened* nationally), popeye shiner, bluebreast darter, tangerine darter, blotchside logperch, longhead darter, the extinct harelip sucker, and the extirpated and nationally *Threatened* yellowfin madtom. The other North Fork species listed, blueside darter, is a tributary form.

The main industrial plant on the North Fork Holston ceased operation in 1972, but chemical contents of abandoned settling lagoons are subject to erosion and seepage into the river, and the rate of recovery of the river has been slow (Hill *et al.*, 1975). Based on the report by Hill *et al.* (1975), subsequent study by biologists of the Tennessee Valley Authority, and our collections and snorkeling observations, the fish species richness in the Washington County section is significantly lower than that in Smyth County above Saltville and below Washington County, in Scott County, and in Tennessee (see accounts of North Fork species, particularly spotfin chub). The spotfin chub and yellowfin madtom have not reappeared above Saltville, possibly due to siltation, and the river redhorse is unknown to have occurred recently in the lower river, perhaps because of pollution in the main Holston River from the highly industrial Kingsport, Tennessee area.

The North Fork Holston has been designated as Critical Habitat relative to the spotfin chub from its mouth in Tennessee through Scott and Washington counties to the Washington-Smyth county line (Federal Register 1977, Vol. 42, No. 8, p. 2514).

The Clinch River and its largest tributary, Powell River, have the most speciose fish fauna in Virginia. The fauna above Norris Reservoir, Tennessee, was documented by Masnik (1974). Of the 20 Tennessee drainage species recommended for status, 14 are known from the Clinch system of Virginia and 2 additional (spotfin chub, harelip sucker) probably occurred there. The ashy darter, *Etheostoma cinereum*, of *Undetermined Status*, also is known from Clinch River. Nearly all 15 Clinch system species are riverine or large stream fishes. Six were found to be confined to the main channel of the Clinch, and in some cases Powell River: paddlefish, emerald shiner, steelcolor shiner, brook silverside, ashy darter, and channel darter. Seven inhabit only the main channel and lower section of one, two or three larger tributaries: popeye shiner, river redhorse, bluebreast darter, Tippecanoe darter, tangerine darter, blotchside logperch, longhead darter. The other two

species, yellowfin madtom and dusktytail darter, are known in Virginia from only one of the larger tributaries, but both inhabit(ed) large rivers in Tennessee.

The Clinch and Powell have long been stressed by the coal industry, operating in tributary watersheds within the edge of the Appalachian Plateau. Principal problems appear to be siltation from mine sites and readily suspendable coal particles from washing operations (summary in Masnik, 1974); acid wastes may also be involved. Although attempts are being made to reduce these hazards to aquatic life, mining continues at a high rate.

Fish kills in Clinch River due to major chemical spills from a power plant in Carbo, Russell County, have taken a heavy toll. The widely publicized alkaline spill in 1967 had drastic effects from Carbo through Scott County, dissipating in Tennessee. An acid spill in 1970 had effects in Russell County. For details of these and other fish kills, see Crossman *et al.* (1973); Masnik (1974); Jenkins (1975c); McLeod and Moore (1978); Raleigh *et al.* (1978); and the account herein of the Tippecanoe darter. Raleigh *et al.* (1978) found that general recovery of fish populations following kills in the Clinch was relatively rapid, but noted a slight decrease in number of species. The records of many of the species treated herein are concentrated just above the Carbo power plant and near the Tennessee line, suggesting that the rare riverine species generally recover relatively slowly. Certain species, such as the ashy darter, may have been extirpated.

Critical Habitat has been designated (Federal Register 1977, Vol. 42, No. 8, p. 2514-2515): Clinch River from Norris Reservoir, Tennessee, upstream through Russell County; Powell River from Norris Reservoir up to the Lee-Wise county line, Virginia. Designation was made in reference to the nationally *Threatened* yellowfin madtom, slender chub, *Hybopsis cahni* (known only in Tennessee but possibly at least formerly of occurrence in Virginia), and certain molluscs, and it protects a large number of other aquatic forms in jeopardy.

Copper Creek

More fish species (69) have been found in this major Clinch River tributary in Scott and Russell counties than in any other except Powell River (Jenkins and Burkhead, 1973). It contains the only Virginia population of the undescribed duskytail darter which merits *Threatened* status nationally, and the only extant Virginia population of the nationally *Threatened* yellowfin madtom. Additionally, it houses the following seven, mostly of *Special Concern:* popeye shiner, river redhorse, Tippecanoe darter *(Threatened*, possibly *Extirpated)*, bluebreast darter, tangerine darter, blotchside logperch, longhead darter.

Copper Creek is in fairly good condition but we doubt that it is much better than some other streams of similar geology in the upper Tennessee. It has some moderately silted sections in agricultural areas. Its species richness probably relates partly to location in a limestone (not coal-bearing) valley in the Ridge and Valley Province, diverse habitats, and size (medium, 98 kilometers, 61 miles in length); additionally, it has been intensively collected. The two other largest Clinch-Powell system tributaries in Virginia are Guest and Little rivers. The former drains largely through the Appalachian Plateau and is subject to the effects of coal mining; it has not been well collected, but the collections suggest the fauna is smaller than that of Copper Creek. Little River, in the Ridge and Valley at the head of Clinch River, has a rich fauna including some species listed herein; when its lower section is sampled intensively, it may be found to have a fauna essentially similar to that of lower Copper Creek.

Copper Creek has been designated as Critical Habitat (Federal Register 1977, Vol. 42, No. 8, p. 2515) relative to the yellowfin madtom.

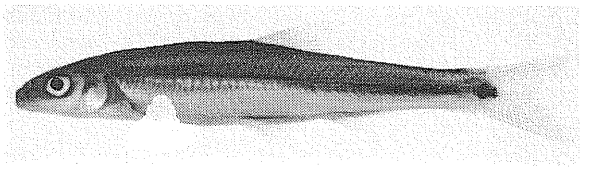
SPECIES ACCOUNTS

ENDANGERED (3)

Tennessee River Drainage (2)

1. SPOTFIN CHUB *Hybopsis monacha* (Cope)

Phylum: Chordata
Class: Osteichthyes
Order: Cypriniformes
Family: Cyprinidae



Description: Body elongate; eyes small, laterally placed; mouth inferior, medial part of upper lip expanded anteriad; one pair of minute terminal labial barbels or, occasionally, barbels absent; teeth 4-4; anal fin rays 8; scales moderate to somewhat small, 52-62 along lateral line; caudal spot large and with anterior portion larger than posterior part; posterior part of dorsal fin with dark area or moderate amount of melanophores in membranes; body lacks blotches and speckling. Color in life: juveniles, adult females and non-breeding males olive above, sides largely silvery, lower parts white; large nuptial males have brilliant turquoise-royal blue on upper parts of body, and all fins tipped with satiny white. Small species, adults about 55-77 millimeters SL (Jenkins, 1975a; Jenkins and Burkhead, manuscript). Illustration: Eddy, 1969.

Present Range: Endemic to Tennessee River drainage. Known from 12 tributary systems, persisting in only three: North Fork Holston River, Tennessee and Virginia; Little Tennessee River, North Carolina; Emory River, Tennessee. Occupies Ridge and Valley province in Virginia, Blue Ridge or uplands elsewhere.

Distribution in Virginia: North Fork Holston River, Scott County, at three shoals (and in the short segment of the North Fork in Tennessee; total 41 kilometers). Formerly from the North Fork above and in the vicinity of Saltville, Smyth County (Figure 2).

Habitat and Mode of Life: Medium to large, typically clear, warm, freely flowing streams. Apparently restricted in North Fork Holston to areas of moderate to rapid flow over major bars and beds of unsilted small gravel (most substrate particles of 2 centimeters and smaller in size). Generally rare. Found among rubble and boulders in other streams. Feeds benthically, and perhaps in midwater, on small immature insects. Apparently largely a sight feeder (Reno, 1969; Jenkins and Burkhead, manuscript); feeds diurnally but may also feed at night.

Reproduction: Spawning probably occurs in June, possibly beginning in May and extending to July. Reproductive behavior unknown. Does not breed until third or fourth year of life; probably spawns only one or two years before death. Fecundity normal for cyprinids of its size and body form; total mature ova 589 and 791 in females of 72 millimeters and 77 millimeters SL, respectively.

Number in Captivity: None.

Status: *Endangered* in Virginia. *Threatened* nationally (Federal Register, 1977), *Endangered* in North Carolina (Bailey, 1977) and Tennessee, *Extirpated* in Alabama (Ramsey, 1976) and Georgia. Disappeared in some streams due to impoundment, siltation, pollution, and/or rotenone renovation, but reasons for demise in others are unknown. Probably declined in North Fork Holston due to chemical pollution from Saltville and siltation (Hill *et al.*, 1975), and possibly by intensive collecting on localized gravel bars. Critical Habitat designated in North Fork Holston: junction with South Fork in Tennessee through Scott and Washington counties, Virginia.

Protective Measures Proposed: Enforcement of law regarding Critical Habitat and practice of soil conservation to reduce siltation.

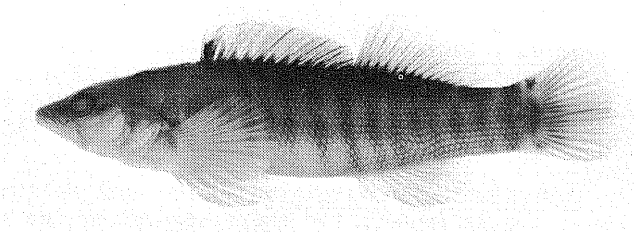
Remarks: The blue-bodied, white-finned nuptial male is a strikingly beautiful fish. The species is of considerable significance in determination of phyletic interrelationships among some major groups of American cyprinid fishes. It has vanished from most of its range and appears to be extinction-prone.

Author: Robert E. Jenkins.

* * * * * * * * * *

2. SHARPHEAD DARTER *Etheostoma acuticeps* Bailey

Phylum: Chordata
Class: Osteichthyes
Order: Perciformes
Family: Percidae



Description: Snout acute, body compressed; lateral line complete, with 54-65 scales; head, breast and nape scaleless; branchiostegal membranes narrowly conjoined; lateral body in adults with 12-16 oblique dark bars. Color in life subdued, olive to greenish dorsally and laterally; body lacks red spots in life and pale spots in preservative; fins lack dark margin; subocular spots, streaks or bar faint or absent; breast may have greenish-blue tint and some fins may have yellow or orange wash. Adults range between 40-60 millimeters SL. Illustrations: Bailey, 1959.

Present Range: Endemic to upper Tennessee River drainage. South Fork Holston River, Virginia (and formerly Tennessee); Nolichucky River, Tennessee, and its major tributary in North Carolina, the Toe River system (Bailey, 1959); Zorach and Raney, 1967; Jenkins and Burkhead, 1975b; Saylor and Etnier, 1976). Occupies Ridge and Valley and Blue Ridge provinces.

Distribution in Virginia: Known from three specimens taken during 1972 from a single riffle in South Fork Holston, Washington County, at river kilometer 119.7, along Route 711 between the junction of Routes 710-711 and the junction of Routes 711-810. Sections above and below the riffle have been well surveyed (Figure 2).

Habitat and Mode of Life: Medium to large, cool to warm streams where it occupies runs and riffles with clean gravel to boulder substrate. Consumes immature insects, apparently diurnally (Jenkins and Burkhead, 1975b).

Reproduction: Behavior unknown. Spawning probably begins in June; mature specimens are 2 and 3 years old. Fecundity data (Jenkins and Burkhead, 1975b) inadequate for determination of reproductive potential.

Number in Captivity: Unknown, but has been kept in aquaria (N. M. Burkhead, pers. comm.).

Status: *Endangered* in Virginia. Considered *Endangered* nationally at 1974 workshop sponsored by The Wildlife Society. Revised to *Threatened* nationally (but not under legislation currently) due to recent discovery of Nolichucky population. The known site of occurrence in Virginia is only about 1.7 kilometers upstream from the head of South Holston Reservoir; the species undoubtedly would not survive in reservoir conditions. It may be locked into this section because of decreasing stream size upstream. Additionally, the nearby and largest South Fork Holston tributary in Virginia, Laureal Creek (entering at 6.3 kilometers above the collection site), has been chronically stressed by domestic and industrial (particularly American Cyanamid Corp.) pollution recovery zone. However, an agreement recently signed between American Cyanamid, the Environmental Protection Agency and the State of Virginia (Water Control Board) will lead to the start of construction in 1978 of an effluent treatment facility (Durwood Willis, Virginia Water Control Board, pers. comm.) In 1977, operation of a sewage treatment plant began in Damascus, but adjustment of waste chlorination has been a problem (Sylvester Taylor, Virginia Water Control Board, pers. comm.). Although water quality apparently is being upgraded, the Virginia population probably will remain in jeopardy. The population apparently is small and probably competing with other members of the subgenus *Nothonotus* that are more numerous and widespread in the South Fork Holston. Abandoned manganese mines in the upper South Fork Holston watershed (references in Jenkins and Burkhead, 1975b) cause considerable siltation in that area, but their effect on the section inhabited by *Etheostoma acuticeps* is unknown.

Protective Measures Proposed: Implementation of industrial effluent treatment; chlorinate wastes at only low levels, or dechlorinate wastes; reduce siltation rates in watershed; designation of species as *Threatened* nationally, and listing of South Fork Holston in Virginia as Critical Habitat.

Author: Robert E. Jenkins.

* * * * * * * * * *

Diadromous (1)

3. SHORTNOSE STURGEON *Acipenser brevirostrum* Lesueur

Phylum: Chordata
Class: Osteichthyes
Order: Acipenseriformes
Family: Acipenseridae

Description: A small dark sturgeon which may be distinguished from its sympatric congener *Acipenser oxyrhynchus* by its smaller lateral dermal shields, wider mouth (less than three fifths width of bony interorbit), a single row of dermal shields between the pelvic and anal fins, and its darkly pigmented intestine. Further diagnostic characters and illustrations may be found in

Gorham and McAllister (1974) and Vladykov and Greeley (1963). The figures purported to be *Acipenser brevirostrum* in Goode (1884), Jordan and Evermann (1900) and Hildebrand and Schroeder (1928) actually are based on an adult *Acipenser oxyrhynchus*.

Present Range: Drainages of the Atlantic coast of North America from the St. Johns River, Putnam County, Florida, north to the St. John River, southern New Brunswick, Canada (Gorham and McAllister, 1974). Reproducing populations apparently are present in the St. John River, New Brunswick; Kennebec River, Maine; Connecticut River, Massachusetts; Hudson River, New York; Delaware River; Altamaha River, Georgia (Hoff, 1965; Gorham and McAllister, 1974; Kinnear, in litt.) and perhaps other rivers as well.

Distribution in Virginia: Known from a single specimen, the skin of which is deposited in the Smithsonian Institution (USNM 26273). Musick recently examined and confirmed the identification of this specimen which was collected from the Potomac River by J. W. Milner on 19 March 1876. The specimen has been the basis for reports of *Acipenser brevirostrum* from the Potomac River by Uhler and Lugger (1876), Smith and Bean (1899), Hildebrand and Schroeder (1928), Vladykov and Greeley (1964) and Musick (1972).

Habitat and Mode of Life: An anadromous species, *Acipenser brevirostrum* also may reside in some rivers or estuarine systems all year (Boyle, 1969; Gorham and McAllister, 1974), unlike its congener, *Acipenser oxyrhynchus*, which, upon approaching maturity, migrates to the sea in the winter. The smallest known specimen (USNM 64330) is 185 millimeters FL and was collected from Salmon Creek, North Carolina. The largest specimen (1194 millimeters FL) was caught in Kennebascasis Bay. This specimen weighed 10.1 kilograms, but another shorter specimen from the same locality weighed 13.8 kilograms, and specimens as heavy as 18 kilograms are reported by commercial fishermen. Length-weight relationships have been reported by Gorham and McAllister (1974). These authors have also summarized information on age and growth and report that *Acipenser brevirostrum* attains an age of at least 27 years. Feeding upon the bottom, *Acipenser brevirostrum* has been reported to consume sludgeworms, chironomid larvae and small crustaceans (Vladykov and Greeley, 1964).

Reproduction: Male *Acipenser brevirostrum* have been reported to mature at about 52 centimeters TL at 5 years of age, and females at about 56 centimeters TL at 6 years (Vladykov and Greeley, 1964). Spawning begins as early as April in the Delaware and Hudson rivers (Hoff, 1965; Vladykov and Greeley, 1964) but is later (June to August) to the north in the St. John River, New Brunswick (Gorham and McAllister, 1974). Hoff (1965) has reported this species spawning about 30 kilometers above the Fall Line in a rocky area at the base of a falls in the Delaware River. McAtee and Weed (1915) indicated that this species and *Acipenser oxyrhynchus* ascended the Potomac River to Little Falls, in the Fall Line zone, Washington, D.C., but no farther. All recent records of viable populations (cited above) are from large rivers. It is possible that *Acipenser brevirostrum* requires large rivers with access to rocky substrates for spawning. Such habitats are accessible only in and above the Fall Line zone in those rivers located south of the terminal glacial moraine (from the Delaware River south). Construction of dams on rivers (such as the James, Rappahannock and Susquehanna) in this area could have extirpated *Acipenser brevirostrum* by preventing it from reaching major sections of required spawning habitats.

Number in Captivity: Unknown.

Status: *Endangered* in Virginia. This species is classified as *Endangered* on the U.S. Endangered Species List (Federal Register, Vol. 32, 11 March 1967). It is already protected by Virginia laws Relating to Fisheries of Tidal Waters section 28.1-49.1 (Anonymous, 1974a).

The question exists whether *Acipenser brevirostrum* was ever a member of the Virginia fish fauna. The existence of one specimen collected more than 100 years ago is certainly not good evidence that a viable population (either resident or migratory) ever occurred in the state. Conversely, the species was first discovered and described from the Delaware River estuary, the nearest large estuarine system to the north of the Chesapeake, and apparently the species still spawns there. In addition, viable populations presently exist in river systems to the south of the Chesapeake. Therefore, it is possible that *Acipenser brevirostrum* may have spawned in Virginia's larger rivers at one time or at least may have occurred in Virginia's near-shore waters as a migratory component of populations which spawned elsewhere. As in other Atlantic coast rivers *Acipenser brevirostrum* probably has been *Extirpated* in Virginia because of dam construction and pollution.

Protective Measures Proposed: If *Acipenser brevirostrum* still occurs in Virginia, it should be taken occasionally by the spring gillnet fishery for shad or in spring poundnet catches. The Virginia Institute of Marine Science monitors these fisheries as part of its continuing study of anadromous fishes (supported by the National Marine Fisheries Service). Research has begun on the occurrence and species composition of sturgeons taken incidentally by the alosine fisheries. Through the auspices of the National Marine Fisheries Service the Shortnose Sturgeon Recovery Team is currently attempting to compile and assess all available information on *Acipenser brevirostrum*. Following this compilation the team will make recommendations for re-establishment of the species. Among their options may be fish culture (artificial) fertilization and transplantion of eggs). Such techniques for other species of sturgeons were investigated many years ago (Ryder, 1890). Fish culture of *Acipenser brevirostrum* should be more successful than that of *Acipenser oxyrhynchus* because *Acipenser brevirostrum* is much smaller and easier to handle and modern culture techniques utilizing hormones may be used to produce and maintain fish in spawining condition.

Author: John A. Musick.

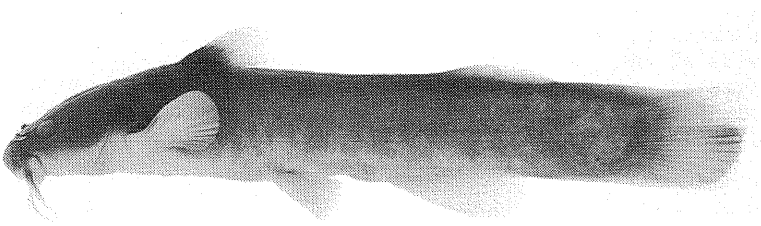
* * * * * * * * * *

THREATENED (6)

Roanoke and James River Drainages (2)

1. ORANGEFIN MADTOM *Noturus gilberti* Jordan and Evermann

Phylum: Chordata
Class: Osteichthyes
Order: Siluriformes
Family: Ictaluridae



Description: Body somewhat robust to rather elongate; head depressed, eyes small; eight barbels; pectoral and dorsal fins short, each with a short spine. Coloration of body and head olive or brown above, pale below, lacking spots and blotches; fins lack dark margin and usually have yellowish wash in undarkened areas; caudal fin particularly diagnostic, mostly dusky to dark, with an obvious pale margin that widens at upper tip of the fin, forming a moderately large and somewhat triangular area that is yellow to orange in life and pale in preservative. Moderate size madtom catfish, adults ranging between 60-85 millimeters SL (Taylor, 1969; Jenkins, 1977b). Illustration: Taylor, 1969.

Present Range: Restricted to upper Roanoke River drainage, Virginia, North Carolina, and Craig Creek system of upper James River drainage, Virginia; Ridge and Valley and upper Piedmont provinces. Total range about 130 stream kilometers.

Distribution in Virginia: Roanoke drainage, four widely separated populations: (1) Upper Roanoke River from Salem into lower North Fork and through upper South Fork into lower Bottom Creek, Roanoke and Montgomery counties; (2) Big Chestnut Creek, a Pigg River tributary, Franklin County, at lower Route 718 bridge (Hambrick, 1973); (3) North Fork of South Mayo River, Patrick County, 3.2 kilometers northwest of Stuart; (4) Dan River, Patrick County, at Route 103 bridge (and in North Carolina down to area of Danbury, Menhinick *et al.* 1974, and pers. comm., 1978; Bailey, 1977). James drainage, about 18 kilometers of Craig Creek centered approximately at Newcastle and approximately the lower 1 kilometer of Johns Creek, a Craig tributary at Newcastle, Craig County. James drainage population possibly established by recent introduction by bait fisherman (Figure 2).

Habitat and Mode of Life: Medium to large, cool to warm streams of moderate gradient and with swifter sections having little or, occasionally, moderate amounts of silt. Juveniles and adults were found exclusively in runs and riffles of gravel, rubble and boulder during all seasons. Young probably tend to occupy slower currents. Mostly nocturnal. Feeds apparently fairly unselectively on immature benthic insects; may be a taste feeder. Generally uncommon or rare.

Reproduction: Spawns apparently in late April and May, possibly early June in cooler section of Dan River. Fecundity very low, about 35-65 ova. Length-frequency data, although inconclusive, suggest males and females mature by second spring after the year of hatching (age-group 2); no age-group 1 specimens were found, and none were apparently older. The smallest specimens studied, 32-33 millimeters SL, were taken in August and September.

Number in Captivity: None, but has been kept in aquaria.

Status: *Threatened* in Virginia. Currently under federal review for *Threatened* status nationally. Upper Roanoke population under increasing stress from urbanization, industry and agriculture (see *Percina rex* account). No recent record for Roanoke River in City of Roanoke, where known in late 1800's. Rare in Salem. Big Chestnut Creek population small, in marginal habitat. No recent record for Mayo River system, where one specimen was taken in 1952. Dan River population probably persisted due to upstream impoundments serving as silt sedimentation basins. Craig Creek population known since 1951 and may be introduced, but no clear evidence of spread found in 1970's; proposal to impound lower Craig Creek and another to designate it as a Virginia Scenic River are forestalled.

Protective Measures Proposed: Designation as *Threatened* nationally and in Virginia; avoid channel modification; possible dams should be dry dams or permanent impoundment should have multiple level water release to retain natural temperature regimen in tailwaters; silt control.

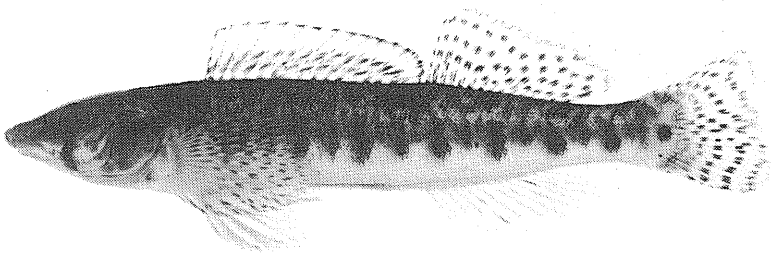
Remarks: A poorly known, geographically relict species with no close relative.

Author: Robert E. Jenkins.

* * * * * * * * * * *

2. ROANOKE LOGPERCH — *Percina rex* Jordan and Evermann

Phylum: Chordata
Class: Osteichthyes
Order: Perciformes
Family: Percidae



Description: Body elongate, cylindrical to slightly compressed; snout moderate to elongate, conic or slightly upturned at tip, and tip is distinctly forward of upper jaw; lateral line complete, scales small, numbering 83-90 in lateral line; nape, cheek and opercle fully scaled or nearly so; mid-ventral scales on belly of male markedly enlarged, spinous. Coloration: back dark to greenish, sides greenish to yellowish, belly white or with yellowish wash. Lateral bars on body prominent, blackish, often slightly disconnected from dark dorsal

marks, or confined to mid-lateral areas as oval blotches; upper sides and back with dark scrawlings; subocular bar, caudal spot and prepectoral spots or blotch well developed; first dorsal fin with black margin and a submarginal, longitudinal, yellowish to red-orange band; second dorsal and caudal fins darkly speckled. Large darter, adults ranging between 80-117 millimeters SL. Illustration: Anonymous, 1974b.

Present Range: Known only from Roanoke River drainage, Virginia; in all three major subdivisions of the drainage, as five widely separated populations: (1) Upper Roanoke, Roanoke and Montgomery counties, from City of Roanoke into lower North Fork and middle South Fork of Roanoke River; (2) Pigg River, Franklin County, just below dam located just above Business Route 220 bridge in Rocky Mount; (3) Middle Roanoke (Staunton) River, Campbell County, within a few kilometers above Brookneal (but the reports of "logperch" by fishery biologists remain unverified by preserved specimen); (4) Town Creek, Henry County, approximately 0.4 kilometer above mouth; and (5) Stony Creek, Sussex and Dinwiddie counties, and lower section of Sappony Creek, its main tributary (Jenkins, 1977a). Occupies Ridge and Valley and Piedmont provinces, and, in Stony Creek, the Fall Line (Figure 3).

Distribution in Virginia: As stated above.

Habitat and Mode of Life: Medium to large, warm, usually clear streams and rivers of moderate gradient with moderately to unsilted substrates varying from gravel to boulder. Within such streams larger juveniles and adults occupy all habitats except over deep silt. At least most of the few young known were captured in pools and slow runs, often over sand. Apparently feeds fairly unselectively on largely immature aquatic insects, occasionally on molluscs. A visual feeder; food frequently sought by overturning stones with snout. Usually exists in low population density, as determined by snorkeling and collecting.

Reproduction: Spawns in June, possibly starting in late May; behavior unknown. All females mature when of age-group 4 (5th year of life); some apparently mature 1 or 2 years earlier; oldest specimen is of age-group 5. Youngest known, 32 millimeters SL, taken 9 July.

Status: *Threatened* in Virginia. Currently under federal review for *Threatened* status nationally. Largest known population, in upper Roanoke, under increasing stress from urbanization, industry and, in upper basin, agriculture; the segments of this population in City of Roanoke and lower Mason Creek had been at very low levels during early 1970's, and may have been extirpated due to chemical spills in 1975 and 1976. Adverse impacts on upper Roanoke River were discussed by: Jackson and Henderson, 1942; McGauhey and Eich, 1942; Cairns *et al.*, 1971; Jenkins and Freeman, 1972; Sherrard and Hoyle, 1977; and Jenkins, 1977a. Recently, flood control structures and/or channel modifications have been proposed for this part of the basin. The Pigg River population is known from a single site. It survived the severe 1975 chemical spill which entered the Pigg immediately below the capture site, but the putative segment of the population extending some 20 kilometers downstream may be extirpated currently. The population of extreme lower Stony Creek is threatened by chlorination from the proposed sewage treatment plant of the Town of Stony Creek. The middle Roanoke (Staunton) River population has been favored by recent designation of a 10-mile section as a Virginia Scenic River.

Protective Measures Proposed: Designation as *Threatened* nationally and in Virginia; avoid channel modification; possible dams should be dry dams or permanent impoundment should have multiple level water release to retain natural temperature regimen in tailwaters; silt control on agricultural lands and roadsides.

Remarks: A large, handsome darter, with fascinating feeding behavior of stone flipping. It is a geographic relict with respect to its closest relatives in the subgenus *Percina*, notably the blotchside logperch, *Percina burtoni*. It is one of the better biological indicators of moderate to good upland stream conditions in the Roanoke drainage, in which it has been widely extirpated; the species is now fractionated into five widely separated populations.

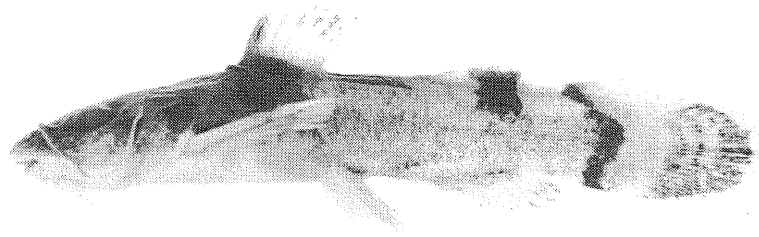
Author: Robert E. Jenkins.

* * * * * * * * * *

Tennesee River Drainage (3)

3. YELLOWFIN MADTOM *Noturus flavipinnis* Taylor

Phylum: Chordata
Class: Osteichthyes
Order: Siluriformes
Family: Ictaluridae



Description: Madtom catfish of moderate proportions, head depressed, eyes large, eight barbels; pectoral spine long, with serrae highly developed. Coloration of back and sides mottled or flecked with dark; four prominent dark saddles -- across back at dorsal fin base, between dorsal and adipose fins, over adipose fin, and from top to bottom in area of procurrent caudal rays and caudal peduncle; back, within dark area just anterior to dorsal fin, with two separate or largely fused pale spots. Dorsal and caudal fins with pale margin and dark band or mottling medially to submarginally. In life, darker areas olive to dark brown, pale body areas and fins with yellowish tinge. Reaches 100 millimeters SL. (Taylor, 1969; Taylor *et al.*, 1971). Illustration: Taylor *et al.* (1971).

Present Range: Known only from upper Tennessee River drainage, in five streams: Copper Creek and North Fork Holston River, Virginia; Hines Creek (lower Clinch River tributary) and Powell River, Tennessee; Chickamauga Creek, Georgia. Ridge and Valley province. All except the Copper Creek and possibly the Powell River populations are extirpated.

Distribution in Virginia: Copper Creek, Scott County, from mouth in Clinch River upstream into Russell County; total about 78 stream kilometers although range may be discontinuous (Figure 3).

Habitat and Mode of Life: Small to large warm streams with moderate gradient and usually clear water with little siltation. Inhabits pools and backwaters, rarely runs. Nocturnally active and then sometimes distant from cover; during daylight under banks or closely associated with other cover types in stream margin shallows and deeper pools. Feeds on moderate variety of immature benthic insects. Probably a taste feeder primarily.

Reproduction: Scant data suggest late spring and possibly early summer as spawning period; fecundity between 100-300 ova. Smallest gravid female 65 millimeters SL, age unknown; longevity probably 4-5 years. Smallest known specimens, 24-29 millimeters SL, taken in September and October.

Number in Captivity: None.

Status: *Threatened* in Virginia. *Threatened* nationally (Federal Register, 1977). *Endangered* in Tennessee. Thought to be extinct (Taylor, 1969) until discovery in Powell River in 1968 and Copper Creek in 1969. Possibly extirpated from Powell River and unknown from the other three localities since late 1800's. One of the latter, the only other known in Virginia, is North Fork Holston River, Smyth County, where specimens were taken just above Saltville (Jordan, 1889; reported as *Noturus miurus)*. The entire North Fork from Saltville downstream has been chronically stressed by chemical pollution (in part, Hill *et al.*, 1975). Above Saltville the river is in fair condition, but the species has not been seen in any of the many recent collections from there. Status of Copper Creek population is unclear. Taylor *et al.* (1971) thought it was fairly common in the lower part of the creek, but more recent and intensive day and night collecting suggests that generally it is uncommon or rare in lower and upper Copper Creek (Jenkins and Burkhead, manuscript; Jenkins, 1975b).

Protective Measures Proposed: Copper Creek into its headwaters and Powell River, Lee County, Virginia (and in Tennessee) have been designated as Critical Habitat for *Noturus flavipinnis* (Federal Register, 1977). Local residents should be made aware of the designations and the designations should be enforced. Copper Creek could benefit from better silt control in agricultural areas along parts of the stream.

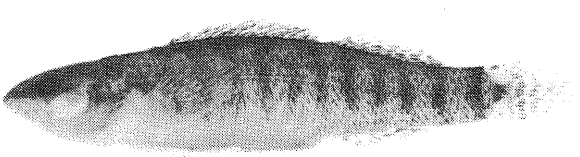
Remarks: Probably a phyletic link between the *furiosus* and *miurus* species -- groups of subgenus *Rabida* (Taylor *et al.*, 1971).

Author: Robert E. Jenkins.

* * * * * * * * * *

4. TIPPECANOE DARTER *Etheostoma tippecanoe* Jordan and Evermann

Phylum: Chordata
Class: Osteichthyes
Order: Perciformes
Family: Percidae



Description: One of the smallest darter species, reaching 35 millimeters SL; body compressed; snout moderately sharp; lateral line incomplete, with 44-52 scales in lateral series, 13-17 unpored. Coloration: males dusky mottled or with 4-11 blue to black bars on sides; ground color of sides pale yellow to orange, breast pale to blue; first dorsal fin golden olive to blackish with a marginal golden band; caudal fin with central bluish to dusky area surrounded by gold. Females subdued in color, appear generally mottled with olive-brown on body, may have a faint golden overcast and a few faint dusky bars (Zorach, 1969). Illustrations: Trautman, 1957; Zorach, 1969.

Present Range: Ohio River basin where it occurs widely but very discontinuously, and within streams, often localized (Zorach, 1969); some populations apparently extirpated.

Distribution in Virginia: Clinch River system: one specimen from Clinch River, Scott County, at Tennessee state line in 1972; one specimen from Clinch River, Russell County at Carbo in 1971 (Masnik, 1974); 11 specimens from Copper Creek, Scott County, just above mouth, during May-August 1967 (Denoncourt, 1969; Jenkins and Burkhead, manuscript) (Figure 4). (Elsewhere in Tennessee drainage known only in Clinch River between Virginia and Norris Reservoir, and in Duck River of lower Tennessee [D. A. Etnier, pers. comm.]).

Habitat and Mode of Life: Medium to large, warm streams and rivers, in sections with little or no siltation. Occupies gentle runs to swift riffles during most of year. Apparently closely associated in Clinch system with small to medium size gravel substrate. Usually uncommon to rare in Clinch River. Trautman (1957) noted wide fluctuations in population density in Ohio.

Reproduction: Apparently spawns in spring. Fecundity low, based on small size of females and normal size of ova. Trautman (1957) found that groups of males guarded eggs and territories in shallow, flowing areas of sandy gravel, and that the territories were usually deserted by storm-caused turbidity and siltation.

Number in Captivity: None known.

Status: *Threatened* in Virginia. Regarded as *Endangered* in Kentucky and Pennsylvania. *Rare* in West Virginia, *Depleted* in Tennessee (Miller, 1972); probably *Extirpated* in Indiana. Although early Clinch records of *Etheostoma tippecanoe* are lacking (only a paucity of ichthyological collections were made in the Virginia section of Clinch River prior to 1970), the current Virginia population probably is a remnant compared to that prior to the 1967 and 1970 fish kills which began at Carbo. The most severe kill, in June 1967, had drastic effects in 106 kilometers in Virginia, and killed organisms in 39 kilometers in Tennessee (Anonymous, 1967; McLeod and Moore, 1978 and references therein). The locality of capture of the specimens taken in 1971 and 1972 bracket the zone of severe kill, but significant repopulation of the Clinch probably would occur very slowly, if at all. The Copper Creek population may be extirpated. All of the Copper Creek specimens were adults and were taken during 1967 within approximately 1 kilometer of the mouth in Clinch River; the section has been intensively collected since 1967. It is likely that the Copper Creek population was reliant on recruitment from Clinch River, and that its apparent demise relates to the 1967 kill.

Protective Measures Proposed: Enforcement of law regarding Critical Habitat designation for Clinch River and Copper Creek.

Remarks: The diminutive golden and blue male Tippecanoe darter can be regarded as an ichthyological jewel.

Author: Robert E. Jenkins.

* * * * * * * * * *

5. DUSKYTAIL DARTER *Etheostoma (Catonotus)* sp.

Phylum: Chordata
Class: Osteichthyes
Order: Perciformes
Family: Percidae

Description: Body moderately compressed; snout moderately pointed to, in adult males, well-rounded; jaws forming end of snout; life colors brownish to olive above, pale below, lacks bright coloration; body with 10-15 narrow, dark bars; caudal fin faintly barred to slightly speckled basally and medially, often slightly to markedly dusky along margin; pectoral, pelvic and anal fins unspotted but dusky along free margin in juveniles and females, black margined in breeding males; head of smaller specimens often dotted below eye with large melanophores. Lateral line incomplete, scales from head to caudal base 38-48, usually 40-45 (48-59 in Copper Creek population of closest relative, *Etheostoma flabellare).* Reaches approximately 50 millimeters SL.

Present Range: Upper Tennessee and middle Cumberland River drainages: Copper Creek, Scott County, Virginia; lower Little River, Blount County, Tennessee; Big South Fork Cumberland River at mouth Station Camp Creek, Scott County, Tennessee (Comiskey and Etnier, 1972). Formerly in South Fork Holston River and Abrams Creek, both Tennessee. Ridge and Valley and Cumberland Plateau provinces.

Distribution in Virginia: Copper Creek from mouth in Clinch River to about 29 kilometers upstream (Jenkins and Burkhead, manuscript) (Figure 2).

Habitat and Mode of Life: Warm, typically clear, medium to large streams and rivers. During other than reproductive period, usually occupies pools and slow runs in areas of, at most, slight siltation; generally under or near stones and other cover. Spawning apparently occurs in riffles or swift runs. Probably a diurnal species. Food habits unknown.

Reproduction: Probably spawns in mid to late spring, depositing egg clutch in a single layer on underside of stones. Gravid females as small as 26 millimeters SL; ages unknown.

Number in Captivity: None; has been kept in aquaria and probably would spawn therein as has its close relatives, *Etheostoma flabellare* and *Etheostoma kennicotti* (Page, 1975a; 1975b and references therein).

Status: *Threatened* in Virginia. *Threatened* nationally as proposed at 1974 workshop sponsored by The Wildlife Society. *Threatened* in Tennessee. The Copper Creek population, the only one known in Virginia, and one of the only three extant, could disappear quickly in the event of a slight increase in siltation, insecticide spraying, or chemical spillage at a bridge or ford. The duskytail darter probably has an intense competitive relationship with the widespread *Etheostoma flabellare*, whose distribution within the Copper Creek system is complemental to that of the duskytail. Copper Creek has been designated as Critical Habitat for other species (Federal Register, Vol. 42, No. 8, 1977). Chronic stress and severe fish kills in Clinch River likely impede its establishment therein; it too has been designated as Critical Habitat for other species.

Protective Measures Proposed: Same as *Noturus flavipinnis* regarding Copper Creek.

Remarks: A somewhat divergent member of subgenus *Catonotus* by virtue of its typical habitation of large streams and rivers.

Author: Robert E. Jenkins.

* * * * * * * * * * *

Diadromous (1)

6. ATLANTIC STURGEON — *Acipenser oxyrhynchus oxyrhynchus* Mitchell

Phylum: Chordata
Class: Osteichthyes
Order: Acipenseriformes
Family: Acipenseridae

Description: A sturgeon which grows to a large size (over 1 meter) and which may be distinguished from its sympatric congener *Acipenser brevirostrum* by its larger overlapping dermal shields, smaller mouth (less than three fifths width of bony interorbit), a double row of dermal shields between the pelvic and anal fins, and its lightly pigmented intestine. Further diagnostic characters and illustrations may be found in Gorham and McAllister (1974) and Vladykov and Greeley (1963).

Present Range: Atlantic coast of North America from Hamilton Inlet, Labrador, south to the St. Johns River, Florida. A separate population in the Gulf of Mexico has been named *Acipenser oxyrhynchus desotoi* Vladykov.

Distribution in Virginia: Recent catches from the Potomac, Rappahannock, York and James River estuaries (Wiley, 1970; Musick, 1972; VCU collection).

Habitat and Mode of Life: An anadromous species which ascends (or ascended) larger rivers to spawn, to about the Fall Line in the Chesapeake basin. Juvenile fish reported to remain in the river or estuary of their birth until about 5 years of age or a length of about 76-90 centimeters (Murawski and Pacheco, 1977). Post-spawning migrations to the sea take place from September to December. Coastal migrations are along the beach usually at depths less than 20 meters and may be as long as 1400 kilometers (Murawski and Pacheco, 1977; Holland and Yelverton, 1973). Suprisingly, evidence of inter-estuarine migration recently came to light when a sturgeon tagged at Montrose Point on

the Hudson River in New York on 19 October 1977 was recovered in a stake gillnet by a commercial fisherman in the York River, Virginia on 2 March 1978. The fish was 76 centimeters in length when tagged. Studies on length-weight relationships and age and growth have been summarized by Murawski and Pacheco (1977). The largest Atlantic sturgeon recorded was a 4.3 meters (14 feet) female weighing 358 kilograms (811 pounds) from New Brunswick, Canada (Vladykov and Greeley, 1964).

Acipenser oxyrhynchus oxyrhynchus is an opportunistic benthic feeder. In marine waters sturgeon have been reported to feed on blue crabs *(Callinectes sapidus)*, polychaete worms, snails, shrimp, amphipods, isopods and small fishes *(Ammodytes* sp.). In fresh water food consists mostly of aquatic insects, amphipods and oligochaete worms (Vladykov and Greeley, 1964; Huff, 1975).

Reproduction: The anadromous spawning migration begins typically in April in Chesapeake Bay (Vladykov and Greeley, 1964). In the Hudson River males do not mature until about 9 years of age (32 kilograms) and females at 10 years of age (68 kilograms). In the St. Lawrence River sexual maturity is not reached by males until 22-24 years and by females until 27-28 years of age.

Fecundity has been estimated at 800,000 to 3,755,745 eggs per female (Vladykov and Greeley, 1964). Spawning occurs at 13.3 to 17.8°C (Borodin, 1925). Spawning usually occurs over hard bottom in running water, often below water falls. Even though spawning in tidal freshwater is probable, suggestions that *Acipenser oxyrhynchus oxyrhynchus* may spawn in brackish water (Murawski and Pacheco, 1977) are at present questionable.

Number in Captivity: Unknown.

Status: *Threatened* in Virginia. Considered *Depleted, Rare* and/or *Endangered* in 13 other states (Miller, 1972).

The history of sturgeon stocks along the eastern seaboard is one of overfishing and decimation by habitat destruction (pollution and dam construction). Even though *Acipenser oxyrhynchus oxyrhynchus* has a high fecundity, its great age to maturity makes the species particularly vulnerable to overfishing. Because it is anadromous in large rivers the species has been particularly susceptible to spawning habitat destruction. Industrial and domestic pollution associated with Fall Line population centers have led to degradation of adjacent riverine and estuarine habitats. Dam construction such as that on the lower Susquehanna River and possibly that associated with navigation canals in Virginia has further reduced the spawning habitat available to sturgeon.

The decline of the sturgeon fisheries has been well-documented by Ryder (1890) and several other authors summarized in Murawski and Pacheco (1977). In Chesapeake Bay, Hildebrand and Schroeder (1928) documented a drastic decline in sturgeon landings from 1880 to 1920. By 1938 a law was passed in Virginia stating that no sturgeon less than 4 feet in length might be removed from the waters of the state. After assessing the extremely depleted condition of sturgeon stocks in the early 1970's we suggested that further protection was needed, and Virginia laws relating to the Fisheries of Tidal Waters (Section 28.1-49.1) now state "It shall be unlawful for any person to take or catch and retain possession of any sturgeon fish..." A few sturgeon are still landed in Virginia because of provisions in the law which allow keeping dead or obviously injured fish (Anonymous, 1974a).

Even though sturgeon are protected in Virginia, our stocks may still be subject to fisheries during their post-spawning migration along the coast. During the colder months, substantial landings of sturgeon are still reported from North Carolina. It is possible that these landings are comprised of fish from Virginia and other mid-Atlantic states that spend the winter along the North Carolina coast.

Protective Measures Proposed: Tagging studies should be initiated to determine whether Virginia sturgeon are being taken by North Carolina winter fisheries. If so, consideration should be given to protection of sturgeon from coastal fisheries. Individual states might still allow estuarine and riverine fisheries for sturgeon where stocks are adequate to support such fisheries.

Author: John A. Musick.

* * * * * * * * * *

SPECIAL CONCERN (26)

Potomac-Shenandoah River Drainage (2)

1. PEARL DACE - *Semotilus margarita margarita* (Cope). Family: Cyprinidae.

This is a northern species, occurring across much of Canada and northern United States (Scott and Crossman, 1973) southward as ecologically restricted populations in Iowa (Menzel and Boyce, 1973), Maryland (Fava and Tsai, 1973), and the Appalachian section of the Potomac-Shenandoah drainage of Virginia. In the latter it is known recently only from cool streams and relatively large spring runs: Back Creek, South River (Ross, 1959; 1972b) and Mossy Creek in Augusta County; Opequon Creek and Chapel Run in Clarke County; Redbud Run and Turkey Run in Frederick County; and Crooked Run in Warren County (Figure 4). These populations appear to be localized remnants of probable wider distribution during Pleistocene glacial times. Distribution very similar to that of *Cottus cognatus*, slimy sculpin. Continued existence in Virginia relates to maintenance of adequate supply of clean cool water.

2. SLIMY SCULPIN - *Cottus cognatus* Richardson. Family: Cottidae.

Widely distributed virtually throughout Alaska, Canada, northcentral and northeastern United States (Scott and Crossman, 1973) southward in the Appalachians on the Atlantic slope into the Potomac-Shenandoah drainage. In the latter it has a fragmented range; it is unknown from the section in Maryland (Lee *et al.*, 1976), and in Virginia it is localized in a few of the smaller cool streams and larger spring runs -- Strait Creek, Laurel Fork and South Fork of the Potomac River in Highland County; Pass Run in Page County; Back Creek, Bakers Spring, Middle River and Mossy Creek in Augusta County (Figure 5). Another Pleistocene relict, similar in distribution and requirements to *Semotilus margarita*. Report of *Cottus cognatus* from the James River drainage (Raney, 1950) is based on one series (CU 10126) of apparently anomalus *Cottus bairdi*.

* * * * * * * * * *

James River Drainage (1)

3. ROUGHHEAD SHINER - *Notropis semperasper* Gilbert. Family: Cyprinidae.

Recently described (Gilbert, 1961) and endemic to the Ridge and Valley province of the upper James River drainage in Virginia. Inhabits upper James River and all eight of its largest tributaries from Maury River upstream, totalling some 432 stream kilometers (Jenkins and Burkhead, 1975a). Occupies medium to large stream sections and often is common. Proposed for rare status by Jenkins (*In:* Miller, 1972) prior to discovery of additional populations. Merits status of *Special Concern* because species has a restricted total geographic range, is confined to main channels, and because of drainage modifications that have been recently completed or are underway or proposed that were discussed by Jenkins and Burkhead (1975a).

* * * * * * * * * *

Roanoke River Drainage (3)

4. RUSTYSIDE SUCKER - *Moxostoma hamiltoni* (Raney and Lachner). Family: Catostomidae.

A swift-water inhabitant known only from relatively unsilted, cool creeks and small streams in the Blue Ridge and immediately adjacent Piedmont uplands of the upper Dan River system, Patrick County, Virginia. Was poorly known and rarely found from 1953 to 1975, after its description by Raney and Lachner (1946), hence thought to have declined and considered "rare" by Jenkins (*In:* Miller, 1972). However, an extensive survey of the Dan system in 1977 by the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Virginia Commission of Game and Inland Fisheries and Jenkins (1977c) found the species, often common, in all streams from which it was formerly known and in additional tributaries. It is known from 12 streams: Little Dan River, Browns Dan River, Hooker Creek, South Mayo River, North Fork South Mayo River, Anglin Branch, Spoon Creek, Rye Cove Creek, Poorhouse Creek, Rich Creek, Rhody Creek and Rockcastle Creek (Figure 3). It is here given status of *Special Concern* because of its small total range and apparent sensitivity to heavy or moderate siltation. Records of the species from the upper Roanoke drainage proper are based on the very similar torrent sucker, *Moxostoma rhothoecum* (Jenkins *et al.*, 1972; Buth, 1977).

5. ROANOKE BASS - *Ambloplites cavifrons* Cope. Family: Centrarchidae.

This species has a small geographic range for a centrarchid. It inhabits the Neuse and Tar drainages in North Carolina and the Roanoke drainage, including the Nottoway and Meherrin branches of the Chowan system, in Virginia (Cashner and Jenkins, manuscript). Although its biology is fairly well-known in North Carolina (W. B. Smith, 1971) and it is under culture in North Carolina (W. B. Smith, 1971) and Virginia, attempts to establish new populations in North Carolina have been unsuccessful (W. B. Smith, pers. comm., 1977), and its natural distribution and biology in Virginia are poorly known. Extant populations are verified in the following: Stony Creek in Sussex County; North Meherrin River in Lunenburg County; Meherrin River in Brunswick County; Falling River in Campbell County; Pigg and Blackwater Rivers in Franklin and Pittsylvania counties; and Town Creek in Henry

County (Figure 4). The upper Roanoke population, above the City of Roanoke, was extirpated during the 1950's, just subsequent to establishment by introductions of a population of northern rockbass, *Ambloplites rupestris* (Cashner and Jenkins, manuscript). It is listed as *Special Concern* because few populations are documented, the density and range limits of most populations are unknown, the species appears to avoid streams or stream sections with heavy siltation, and because of its suitability as a sport fish. Most citation size catches of "rock bass" in Virginia probably are of *Ambloplites cavifrons* rather than *Ambloplites rupestris*. The distribution and value of *Ambloplites cavifrons* may become augmented in the future, with greater control of sedimentation in Piedmont and other watersheds.

6. BLACKBANDED SUNFISH - *Enneacanthus chaetodon* (Baird). Family: Centrarchidae.

A small secretive sunfish ranging on the Coastal Plain from New Jersey to Florida. Only two Virginia records, both recent and in the Chowan system: Blackwater Swamp, a Blackwater River tributary in Prince George County (Jenkins *et al.*, 1975); and Game Refuge Lake, Nottoway River watershed in Sussex County (Figure 4). The species is unknown from the Coastal Plain of the entire western Chesapeake Bay basin, and it is rare in the lower Chowan and Roanoke of North Carolina. Graham (1977) found that *Enneacanthus chaetodon* has close competitive interactions with other centrarchids. Accorded status of *Special Concern* because only two populations are known in a fairly large and possibly more widely inhabitable area, namely the southeastern Coastal Plain backwaters. Not regarded as peripheral since the Virginia record sites are in a region that otherwise forms a major hiatus in the range of the species, the basis of which is not understood.

* * * * * * * * * *

Peedee River Drainage (4)

7. HIGHBACK CHUB - *Hybopsis hypsinotus* (Cope). Family: Cyprinidae.

Its range is the Piedmont and Blue Ridge sections of the Santee and Peedee drainages, South Carolina and North Carolina, just extending into Virginia in the Peedee via Yadkin River tributaries. Three records: Pauls, Lovels, and Brushy creeks in Carroll County (Figure 4). This and the following three species are given *Special Concern* status due to their extremely small range in Virginia, because they are uncommon to rare therein, and because the larger sections of Yadkin tributaries just above the North Carolina state line are considerably silted. The four species typically do not ascend into small creeks; sections producing the records may now be marginal habitat owing to continuing heavy silt and sand sedimentation and turbidity. The four are peripheral species.

8. THICKLIP CHUB - *Hybopsis labrosa* (Cope). Family: Cyprinidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*. Record: Ararat River in Patrick County. (May be extirpated as only record dates from 1933) (Figure 5).

9. SMALLFIN REDHORSE - *Moxostoma robustum* (Cope). Family: Catostomidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*, except occurs farther south on Atlantic slope. One record: Ararat River in Patrick County, 1972.

10. PIEDMONT DARTER - *Percina crassa* (Jordan and Brayton). Family: Percidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*, except occurs also in Cape Fear River drainage in North Carolina. (Another form, formerly *Percina crassa roanoka*, is regarded as a full species according to Page [1974] and his subsequent study.) Three records: Halls Branch in Carroll County; Ararat River in Patrick County -- one of the records during 1976, another in 1977.

* * * * * * * * * *

New River Drainage (1)

11. SAND SHINER - *Notropis stramineus stramineus* (Cope). Family: Cyprinidae.

The sand shiner is widely distributed in southeastern and south central Canada, southward in much of the Ohio River basin and through central United States into Texas (Pflieger, 1975). Only one specimen is known from Virginia, at virtually the West Virginia state line, in an area that recently has been intensively collected: East River near its mouth in New River, just below a heated discharge, during 1973 (Stauffer *et al.*, 1975). Scattered populations of *Notropis stramineus* occur in the West Virginia part of the New drainage. The species merits status of *Special Concern* owing to the singularity of the record and industrial development of the area from which it emanated. Clearly peripheral in Virginia.

* * * * * * * * * *

Tennessee River Drainage (14)

12. PADDLEFISH - *Polyodon spathula* (Walbaum). Family: Polyodontidae.

An archaic riverine and lentic inhabitant widely distributed in Mississippi River basin and Mobile Bay drainage. One large, very robust specimen (about 30 kilograms, 1.5 meters FL) was first sighted in Clinch River approximately 4 kilometers above Tennessee state line on 13 June 1967. The specimen was drifting and in stress from a severe chemical spill and died upon being hauled into a small tributary. Two somewhat smaller specimens were reported by game wardens to have been found dead at the same time in the lower Clinch of Virginia. The species normally may not reside permanently in Virginia. It may regularly migrate into Virginia via the Tennessee stretch of Clinch and possibly Powell rivers, perhaps ultimately from Norris Reservoir. It probably has redispersed into Virginia following the 1967 kill. Anglers informed Masnik (1974) that paddlefish have occurred in the Clinch up to Dungannon, northeastern Scott County. *Endangered* in North Carolina (Bailey, 1977). *Rare* or *Depleted* in several other states (in part, Miller, 1972). Peripheral.

13. POPEYE SHINER - *Notropis ariommus* (Cope). Family: Cyprinidae.

Occurs widely in southern half of Ohio River basin, few old records from northern Ohio basin, one for Lake Erie drainage (where it is extirpated), and a questionable one for Missouri Ozarks (Gilbert, 1969). Typically in medium to large streams, in gentle flow over largely gravel substrate within relatively unsilted areas. Occasionally common. *Virginia records:* North Fork Holston River where it appears to be continuously distributed since 1970 from Tennessee

state line to slightly above Saltville; Clinch River since 1969 just above and below Carbo; Copper Creek once in 1971 just above mouth; Powell River since 1968 in Lee and Wise counties. Although there are a number of recent records from all of the above streams except Copper Creek, the species should be watched. Some of the northern populations apparently are extirpated, and it was almost totally absent from collections made in the Ohio basin during 1894-1948 (Gilbert, 1969). May be considered peripheral, a tenuous decision considering its distribution and abundance over total range.

14. EMERALD SHINER - *Notropis atherinoides* Rafinesque. Family: Cyprinidae.

Typically occupies large rivers and lakes and ranges widely in United States and Canada (Pflieger, 1975). Two records: Powell River, Lee County, in 1968; Clinch River, Russell County, at a short distance below Carbo, in 1969. Peripheral.

15. STEELCOLOR SHINER - *Notropis whipplei* (Girard). Family: Cyprinidae.

Widely distributed in central Mississippi River and Ohio River basins (Gibbs, 1963). Typically restricted in upper Tennessee River drainage to large streams and main rivers. Three records: Clinch River, Scott County, between Tennessee state line and Clinchport in 1954 and 1970, and Stock Creek just above its mouth at Clinchport in 1969. Peripheral.

16. FATLIPS MINNOW - *Phenacobius crassilabrum* Minckley and Craddock. Family: Cyprinidae

Endemic to upper Tennessee River drainage, largely in Blue Ridge province, from Little Tennessee River system to South Fork Holston River, Georgia, North Carolina, Tennessee and Virginia (Minckley and Craddock, 1962; Dahlberg and Scott, 1971). Occupies moderate to swift waters of medium to large size, cool to warm, high gradient streams. *Virginia records:* South Fork Holston River from arm of South Holston Reservoir at Alvarado through 11 kilometers to Route 91 bridge; Laurel Creek, a major South Fork Holston tributary, just above Damascus; all records are from Washington County (Figure 4). Of *Special Concern* due to pollution as noted in account of *Etheostoma acuticeps*. Not regarded to be in greater jeopardy because species apparently persisted in Laurel Creek above outfalls in Damascus and occurs in South Fork Holston above (and below) mouth of Laurel Creek. Peripheral.

17. RIVER REDHORSE - *Moxostoma carinatum* (Cope). Family: Catostomidae.

Widely distributed in central United States, including nearly throughout the Ohio basin and with a relict population in Southern Canada (Jenkins, 1970). Depleted or exirpated in some areas, notably fringes of western and northern parts of range. A large stream and river migratory species that spawns in moderate to swift currents on clean gravel and small rubble. *Numerous records in Virginia:* Extends into all major Tennessee drainage tributaries except the North Fork Holston. The South and Middle Forks Holston records are from their lower section in Washington County. Occupies the Scott County and Russell County portions of Clinch River, and inhabits Powell River into eastern Lee County. Verbal reports of spawning in lower Copper Creek, but young probably disperse out into Clinch River fairly quickly as there are no records of capture for this intensively sampled section. Recent records for Clinch River only from fringes of highly stressed section. Probably once occupied North Fork Holston in Tennessee and Virginia up to Saltville area. Peripheral, but has declined widely outside of Virginia.

18. BROOK SILVERSIDE - *Labidesthes sicculus sicculus* (Cope). Family: Atherinidae.

Widely distributed from southern Canada to the Gulf of Mexico (Pflieger, 1975). Occupies small streams in many areas, but in upper Tennessee drainage it is usually found in large streams and rivers. *Virginia records:* Clinch River, Scott County, from Tennessee state line to Clinchport; Powell River, Lee and Wise counties; all records since 1967. Peripheral.

19. BLUEBREAST DARTER - *Etheostoma camurum* (Cope). Family: Percidae.

Confined to the Ohio River basin where it inhabits swift sections of medium to large streams and rivers (Zorach, 1972). Ranges widely throughout basin and is disjunct in many areas. *Virginia records:* Clinch River, lower Copper Creek and North Fork Holston River (Figure 5). In both the Clinch and Holston, the records are concentrated near the Tennessee state line and just above sites of major industry: Carbo in the Clinch and Saltville in the Holston. The intervening sections of approximately 100 kilometers and 80 kilometers in length, respectively, yielded few recent records, all within about 10-20 kilometers of the industrialized areas: two records at Carterton, Clinch River, in 1969 and 1972; two records at McKenna Island in North Fork Holston during 1973 and 1975. Hence, the bluebreast darter appears to be redispersing into formerly highly stressed areas. Considered peripheral, but the upper Tennessee drainage population is one of the healthier populations, and the species has declined in some parts of its disjunctive range.

20. GREENFIN DARTER- *Etheostoma chlorobranchium* Zorach. Family: Percidae.

Endemic to Blue Ridge section of upper Tennessee River drainage, Georgia, North Carolina, Tennessee (Zorach, 1972) and Virginia. In swift, hard-bottomed waters of cool to warm, medium to large streams. *Virginia records:* (Whitetop) Laurel Creek, tributary of South Fork Holston River, at Taylors Valley, Washington County, in 1970 and 1976. Rare at this locality (Figure 5). Here listed, although the locality is above pollution outfalls in Damascus, because species is probably limited to this one stream. Peripheral.

21. BLUESIDE DARTER - *Etheostoma jessiae* (Jordan and Brayton). Family: Percidae.

Endemic to certain parts of upper and middle Tennessee River drainage, Alabama, North Carolina, Tennessee and Virginia; replaced in upper Clinch and Powell River systems by another form of the *Etheostoma stigmaeum* species group (W. M. Howell, pers. comm.). Prefers small to medium size, moderate gradient streams that typically are clear. *Virginia records:* one specimen each from North Fork Holston River tributaries, Scott County - lower Cove Creek in 1937; lower Opossum Creek in about 1971 (Howell, pers. comm.). *Endangered* in North Carolina (Bailey, 1977). Peripheral.

22. TANGERINE DARTER - *Percina aurantiaca* (Cope). Family: Percidae.

This large, beautiful darter is restricted to the upper Tennessee River drainage in Georgia, North Carolina, Tennessee and Virginia (Howell, 1971; Thompson, 1972). Inhabits deeper runs and well-flowing parts of pools in sections of medium to large streams with firm substrate. Typically exists in low population density; easily inventoried by snorkeling. *Virginia records:* recent records for North Fork Holston River in western Scott County, above

Saltville, and one approximately 20 kilometers below Saltville (Hill *et al.*, 1975); Clinch River from Tennessee state line into western Russell County; lower Copper Creek and upper Guest River, both Clinch River tributaries; Powell River, Lee County. Depleted in highly stressed section of North Fork Holston and Clinch rivers; no recent record for Guest River, perhaps due partly to increased strip mining in the watershed (Masnik, 1974).

23. BLOTCHSIDE LOGPERCH - *Percina burtoni* Fowler. Family: Percidae.

Widely but rather disjunctively distributed in most upland and montane parts of Tennessee River drainage; known from middle Cumberland River drainage but no recent verified records (Jenkins and Zorach, under study). Occupies medium to large streams and small rivers, where it is found in shallow and deeper sections of riffles, runs and pools, but at least usually only in areas lacking appreciable siltation. Feeds often by turning stones, as noted for its close relative, *Percina rex*. Exists in low population density, determined partly by snorkeling. *Virginia records:* North Fork Holston River above Saltville; Clinch River from Tennessee state line to Copper Creek mouth, and above Carbo in Russell County; Copper Creek from mouth to lower headwaters; lower Little River, the major upper Clinch River tributary. Regarded as *Rare* in Tennessee and Virginia (Etnier and Jenkins *In:* Miller, 1972).

24. CHANNEL DARTER - *Percina copelandi* (Jordan). Family: Percidae.

This fairly widespread darter was depicted (Pflieger, 1975) as composed of three broadly separated populations: middle and upper Ohio River-Great Lakes basins; south-central United States; and southeastern Gulf slope. Clay (1975) and Comiskey and Etnier (1972) reported it additionally from the Cumberland drainage. It is now known also from the Tennessee drainage; but only in the Clinch system of Tennessee and Virginia (Etnier, pers. comm.; Masnik, 1974). *Virginia records:* Clinch River, Scott County, between mouth of Copper Creek and Tennessee state line, 1972; Powell River, Lee and Wise counties, 1968-1971. It is confined to the medium and larger sections of these streams, and is usually found in runs and riffles with gravel substrate (Figure 3). Not regarded as peripheral because of the disjunction of the population and because *Percina copelandi* appears to be a complex of species or subspecies (R. D. Suttkus, pers. comm.).

25. LONGHEAD DARTER - *Percina macrocephala* (Cope). Family: Percidae.

Ranges in eastern sector of Ohio River basin in New York, Ohio, Pennsylvania, West Virginia and Kentucky and in certain upper Tennessee River drainage tributaries of Virginia, Tennessee and North Carolina. Lives in moderate to large streams typically with little siltation but often with moderate amounts of detritus. Occupies riffles in some areas, but taken in Virginia by Jenkins only from pools or gentle runs. Never found to be common in Virginia. *Virginia records:* Middle Fork Holston River, Washington County (1937 and earlier); North Fork Holston River, several recent records above Saltville and one about 20 kilometers below (at Hayters Gap, Washington County) during 1973; Copper Creek from near mouth to stream kilometer 20 since 1969; Little River, upper Clinch system, at an unknown locality in 1967 (Figure 4). Known from upper section of South Fork Holston River in Tennessee near Virginia state line prior to filling of South Holston Reservoir. Although the longhead darter has a moderately wide range, it is not considered peripheral in Virginia. No recent records are known

from Ohio (Trautman, 1957); considered *Rare* in Kentucky and Pennsylvania (Miller, 1972), *Endangered* and probably *Extirpated* in North Carolina (Bailey, 1977), and *Threatened* in Tennessee.

Estuarine (1)

26. MARSH KILLIFISH - *Fundulus confluentis* Goode and Bean. Family: Cyprinodontidae.

Ranges from Chesapeake Bay, Maryland to vicinity of mouth of Pensacola Bay, Alabama (Miller, 1955; Musick, 1972). Typically in brackish water, but enters fresh and polyhaline water. Occupies muddy marshes and grass flats. *Virginia records:* Known only from Lynnhaven Inlet, Virginia Beach (several specimens including gravid females, Hildebrand and Schroeder, 1928), and recently from lower York River, Gloucester Point (three, possible strays, VIMS 206, 4947). The rarity of the species in Virginia could be due to marginal environmental conditions at edge of species' range. Conversely, this small species is superficially similar to the common *Fundulus heteroclitus*, and *Fundulus confluentis* may be more widespread but unrecognized. Such is the case with *Fundulus luciae*, which was once considered rare, but is known now to be a common inhabitant of very shallow high marsh habitats in Virginia (Byrne, 1976). It seems prudent to classify this species in Virginia under *Special Concern;* peripheral.

STATUS UNDETERMINED (5)

1. WHITEMOUTH SHINER - *Notropis alborus* Hubbs and Raney. Family: Cyprinidae.

Ranges from Santee drainage, North Carolina, to Roanoke drainage, Virginia (Hubbs and Raney, 1947; Menhinick *et al.*, 1974). Occupies creeks and small to medium size Piedmont streams. *Virginia records:* tributaries of Kerr Reservoir, Mecklenburg County; Horsepen Creek (a tributary of Roanoke Creek), Charlotte County (Figure 5). (Found in Roanoke and Dan River tributaries in North Carolina [Menhinick, manuscript] but not in Dan system during extensive 1977 survey.) All Virginia records date from 1938-1949 and all of the Mecklenburg County records are from streams subsequently impounded. A candidate for *Special Concern* status, but not so accorded, as little collecting effort has been made in the pertinent area since 1950. Occupies same area in Virginia as *Etheostoma collis* (see below).

2. ASHY DARTER - *Etheostoma cinereum* Storer. Family: Percidae.

This generally rare darter of the Tennessee River and the Cumberland River drainages (Clay, 1975; Ramsey, 1976) was taken once (one juvenile, VPI&SU 2153) in Virginia, from the Clinch River in either Scott or Russell County; the exact locality is unknown. The specimen was collected in 1964; hence, the ashy darter may be *Extirpated* due to the 1967 and subsequent fish kills.

3. CAROLINA DARTER - *Etheostoma collis lepidinion* Collette. Family: Percidae.

Etheostoma collis (Hubbs and Cannon) ranges on the outer and middle Piedmont from the Santee drainage, South Carolina, to the Roanoke drainage,

Virginia, except a record is lacking for the Tar drainage, North Carolina (Collette, 1962; Menhinick, manuscript). The species is represented in Virginia by the above subspecies. *Virginia records:* Wards Fork and a "tributary of Horsepen Cr. 2.4 mi NW of Wylliesburg on Rt. 607," both Roanoke Creek watershed, Charlotte County (Figure 5). The latter locality may have been misdetermined by the collector, and may actually be in Sandy Creek, a separate Roanoke River tributary just below Roanoke Creek. The four collections were taken during the period 1935-1959. May merit status of *Special Concern* or *Threatened*, but not so recommended here due to paucity of recent ichthyological survey of the lower Roanoke in Virginia and the fact that *Etheostoma collis* typically inhabits creeks and small streams that often are detritus cluttered; hence, often unattractive and difficult to seine. Would not be considered peripheral because few records of this subspecies exist for North Carolina, where all additional populations reside. Occupies same area in Virginia as *Notropis alborus* (see above).

4. VARIEGATE DARTER - *Etheostoma variatum* Kirtland. Family: Percidae.

Occurs in much of the upper and middle Ohio River basin (Hubbs and Black, 1940; Trautman, 1957). Continuing reports (Clay, 1975) of it from the Tennessee and Cumberland drainages apparently are founded solely on the record of one specimen by Evermann and Hildebrand (1916) from Indian Creek, a Powell River tributary, in Tennessee, near the Virginia state line. Hubbs and Trautman (1932) erroneously ascribed the record to the adjacent Cumberland River drainage. Hubbs and Black (1940) indicated earlier doubt of the "Cumberland" record, but confusingly listed the Tennessee as within the species range. Hubbs and Trautman (1932) and Jenkins could not locate the specimen, and Masnik (1974) thought the record may have been based on *Etheostoma caeruleum*. *Virginia records:* two from Big Sandy drainage, Buchanan County, in 1937 - Levisa Fork, about 5 kilometers above Grundy; Long Branch Creek, tributary of Tug Fork, about 1.6 kilometers above mouth (Figure 5). Possibly *Extirpated* because the Big Sandy in Virginia, Kentucky and West Virginia continues to be degraded by the coal industry. No fish collection data since 1938 are available from the Levisa and Tug Fork systems, except for extreme headwaters which the species usually avoids.

5. BLACKSIDE DARTER - *Percina maculata* (Girard). Family Percidae.

Ranges from southern Canada through central United States and onto Gulf of Mexico slope (Pflieger, 1975). *Virginia records:* two, in same collections as *Etheostoma variatum* (see above) (Figure 5). Possibly *Extirpated*, as considered under latter species. (The population, which is widespread in the New River drainage and until recently was thought to be *Percina maculata*, is being described as a separate species [Beckman, 1977]).

* * * * * * * * * *

RECENTLY EXTINCT or *EXTIRPATED (3)*

1. HARELIP SUCKER - *Lagochila lacera* Jordan and Brayton. Family: Catostomidae.

The monotypic genus *Lagochila* is *Extinct*, the last record of capture dated 1893. It ranged widely in the Ohio River basin and occupied the Maumee River system of the Lake Erie drainage and the White River drainage in the Ozarks (Jenkins, 1970). The sole Virginia record is from North Fork Holston River at Saltville, where Jordan (1889) took "a few specimens" in 1888. This sucker had peculiar, apparently specialized trophic morphology (Jenkins, 1970 and subsequent study). Its extinction may relate to general widespread increase in siltation and turbidity, impoundment, and competition with species with similar food habits.

2. TROUT-PERCH - *Percopsis omiscomaycus* (Walbaum). Family: Percopsidae.

Ranges widely in Canada and northeastern and northcentral United States (Pflieger, 1975). Southern limit on the Atlantic slope was the Potomac River, where it was found in the section between the mouth of the Shenandoah River and Washington, D.C., not later than 1911.

3. NORTHERN LOGPERCH - *Percina caprodes semifasciata* (DeKay). Family: Percidae.

The distribution of this subspecies of *Percina caprodes* (Rafinesque) is similar to that of *Percopsis omiscomaycus*. Its southernmost Atlantic slope population occupied the same part of Potomac River; the last record was in 1910. (The Ohio logperch, *Percina caprodes caprodes*, is widespread in the Tennessee drainage and inhabits a small section of the New River drainage in Virginia).

* * * * * * * * * * *

STATUS UNWARRANTED (5)

The following species have been proposed, formally or informally, for conservation status, but they are thought to not merit status currently in Virginia or nationally. We here record reasons for the decisions.

1. BROOK TROUT - *Salvelinus fontinalis* (Mitchell). Family: Salmonidae.

The natural range of the brook trout is eastern Canada, northeastern United States and the Appalachian chain southward into northeastern Georgia. This species has been introduced widely elsewhere in North America and onto other continents (MacCrimmon and Campbell, 1969; MacCrimmon *et al.*, 1971). In Virginia it occurs in the Blue Ridge and westward, and has an apparently natural population in Difficult Run on the Piedmont of Fairfax County, near Washington, D.C., that was noted as far back as the late 1800's (Smith and Bean, 1899; McAtee and Weed, 1915) (Figure 6). It is stocked annually in the cold tailwaters of Smith River, a medium size stream on the upper Piedmont of Henry County, but it is not known to have become established by natural reproduction.

Many populations are present in Virginia. Nearly all occupy small streams, far into upper headwaters, with cold, usually clear, unpolluted water, and little or insignificant amounts of siltation. The nearly completed intensive survey of trout waters by the Virginia Commission of Game and Inland Fisheries (L. O. Mohn, pers. comm.) has estimated that approximately 1100 to 1200 miles (1970 to 1920 kilometers) of stream currently support wild brook trout. Some of the populations may have been established or re-established by stocking of hatchery-reared fish, but the great majority probably is composed at least largely of ancestors of native fish.

Brook trout populations have become depleted, extirpated or had their range constricted in many Virginia streams. This is a serious trend that has been effected largely by the following: warming of streams due to loss of vegetational shade and hence increased insolation; reduction or increased variation of instream flow volume due to channel modification and deforestation; pollution; siltation; impoundment; and competition with introduced brown and rainbow trout. The rainbow trout often seems to nearly or completely replace brook trout in streams where it becomes naturalized.

We have elected to not recommend the brook trout for formal conservation status. The large number of populations extant in Virginia places the species outside the concept of status categories employed herein. The species is not confined to a few main channels. Instead, the vast majority of the populations are physiographically and/or ecologically isolated from others, and perturbation of one population would not necessarily affect others. Many of the populations are situated in areas that are remote or have little or no disturbance. We feel that problems of this trout are being given considerable attention and that the status of the species may be enhanced upon completion of the statewide trout survey and implementation of recommendations that result. We sense that maintenance of wild trout populations and protection of their habitat are becoming increasingly popular concepts in Virginia at the regulatory and other levels. Additionally, Trout Unlimited, Inc., has gained foothold in Virginia; this group is dedicated to conservation of coldwater fisheries and already has had positive impact.

The guard on brook trout populations should not diminish. This beautiful species is a symbol of Virginia's wildness and healthy watersheds. It is extremely important as a recreational resource, but is rather sensitive to environmental stresses and occupies a habitat that is fragile.

Recently we have heard statements or implications that the "southern Appalachians" brook trout is taxonomically distinct from more northern populations. However, current studies at Tennessee Tech University indicate that no block of southern populations merits separate status on the subspecific or higher levels (R. D. Estes, pers. comm.). It is likely, though, that some populations have developed racial or physiological differences from other populations, and we agree with Behnke (1972) and Trojnar and Behnke (1974) that preservation of intraspecific variability or genetic diversity is of great practical importance.

2. BIGEYE JUMPROCK - *Moxostoma ariommum* Robins and Raney. Family: Catostomidae.

This morphologically peculiar sucker is restricted to the Roanoke drainage, inhabiting both the upper and middle Roanoke proper and upper Dan systems. In the latter, it extends into North Carolina, and the species has been recommended for *Special Concern* status in that state (Bailey, 1977). It was considered to be rare over its range by Jenkins (*In:* Miller, 1972). Subsequently it was newly discovered in several small to medium size streams. Notably, it is unknown to inhabit impoundments, but two of the populations occupy small streams each having its mouth in a large reservoir (Smith Mountain and Philpott); each population has persisted for more than 10 years despite apparent lack of recruitment from larger streams. A measure of the earlier concept of its rarity was based on inadequate knowledge of its typical habitat, now known to be deeper, rocky and well-flowing waters that are difficult to seine effectively. (Jenkins *et al.* [1975] listed *Moxostoma ariommum* from the Chowan system of the Roanoke, but the single series involved [CU 32032, formerly VPI&SU "989" but probably 686] has since been detected to have faulty locality data.)

3. NEW RIVER SHINER - *Notropis scabriceps* (Cope). Family: Cyprinidae.

4. KANAWHA MINNOW - *Phenacobius teretulus* (Cope). Family: Cyprinidae.

5. KANAWHA DARTER - *Etheostoma kanawhae* (Raney). Family: Percidae.

These three lotic species are endemic and unique to the New River drainage and have been recommended for *Threatened* or *Special Concern* status in North Carolina (Bailey, 1977). Two of the species, *Notropis scabriceps* and *Phenacobius teretulus*, occur in all three states drained by the New -- North Carolina, Virginia and West Virginia; *Etheostoma kanawhae* appears to be excluded from the lower and much of the middle section of the drainage by its close relative, *Etheostoma osburni*. There are many Virginia records available for the three species, but most are concentrated in the Blue Ridge province section of the drainage and the species seem to prefer medium and large size streams (Figure 5). *Phenacobius teretulus* best exemplifies such a distribution pattern (map in Hambrick *et al.*, 1975). The main problem that has jeopardized the species was the proposal for a two-dam pumped storage project on New River, the "Blue Ridge project," which was to have extended through the Blue Ridge section of New River in Virginia, well up its main forks in North Carolina, and would have inundated lower reaches of other tributaries. It was questionable that in the event the project became a reality the populations in unimpounded sections of tributaries of the impoundments would survive without recruitment, and that those above and below the project area were sufficiently viable or numerous enough to negate

granting of conservation status to the species. It is now a somewhat moot problem, as 42.6 kilometers of the New River in North Carolina, down to the Virginia line, has been declared a national Wild and Scenic River (Public Law 94-407), thereby blocking the Blue Ridge project.

* * * * * * * * * *

Addendum

The Roanoke bass, *Ambloplites cavifrons*, ranked of *Special Concern* herein and thought to have been extirpated since about 25 years ago from the upper Roanoke River drainage above Smith Mountain Reservoir, was discovered during August 1978 in upper Bradshaw Creek, a North Fork Roanoke River tributary in Montgomery and Roanoke counties. The remnant population is living syntopically with the rockbass, *Ambloplites rupestris*, and may be localized in the creek. Disturbances to the Roanoke bass population and the stream itself should be avoided. The population is under study.

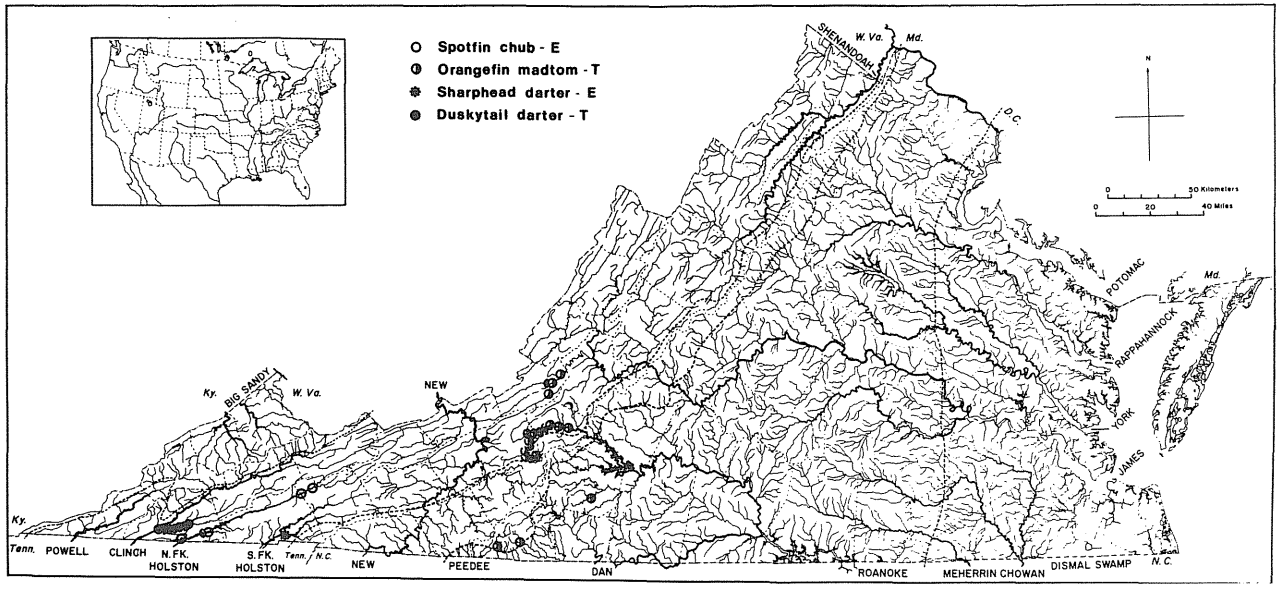


Figure 2. All known locality records of four fishes of Endangered or Threatened status

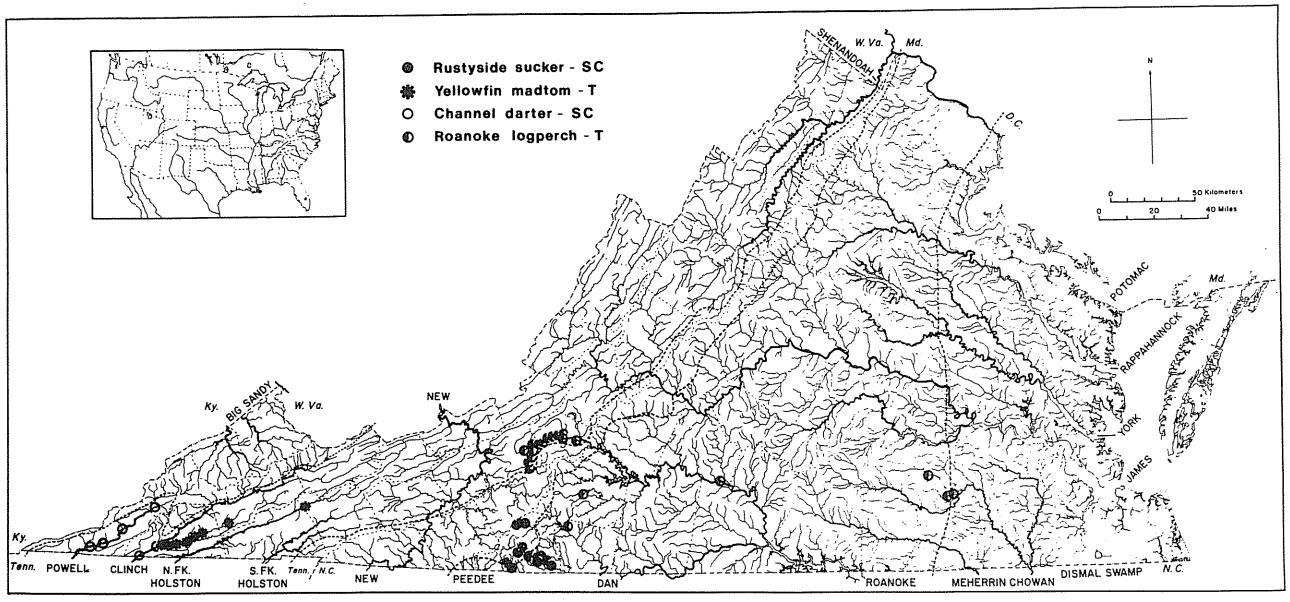


Figure 3. All known locality records of four fishes of Threatened or Special Concern status

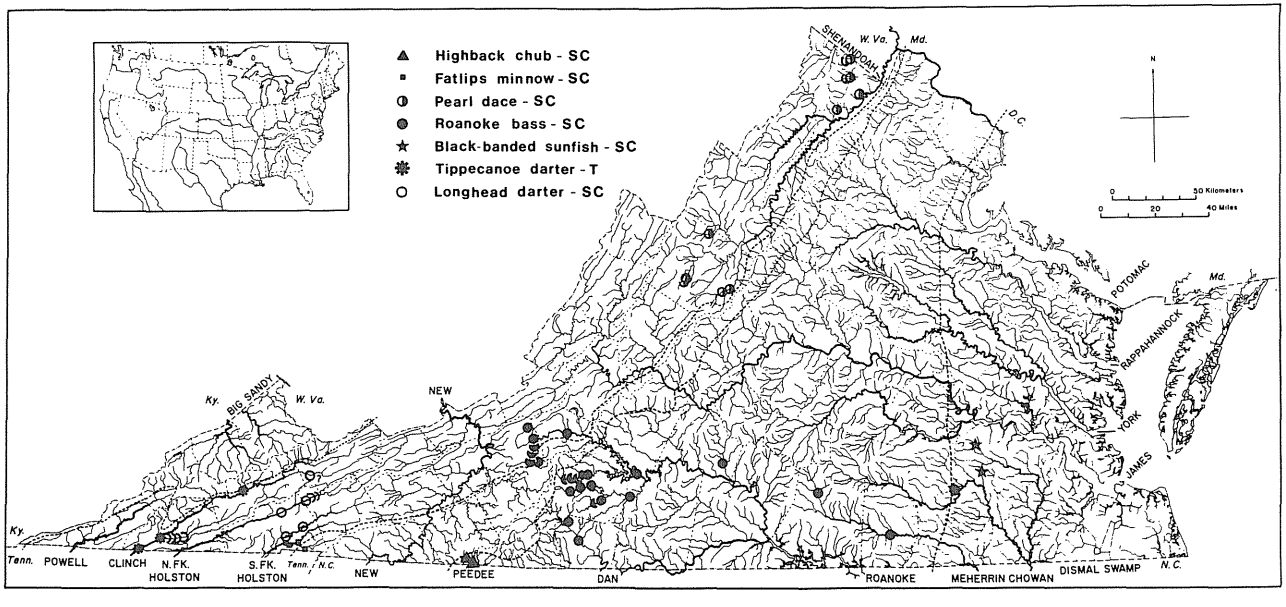


Figure 4. All known locality records of seven fishes of Threatened or Special Concern status

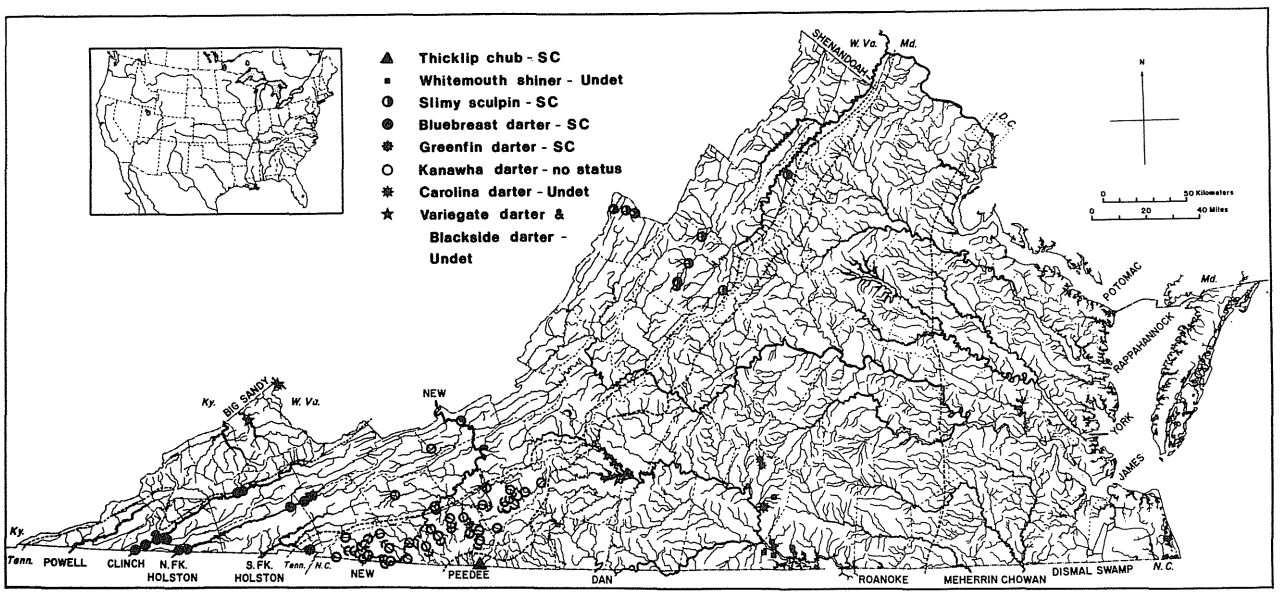


Figure 5. All known locality records of eight fishes of Special Concern or Undetermined status, and of one species which does not warrant status

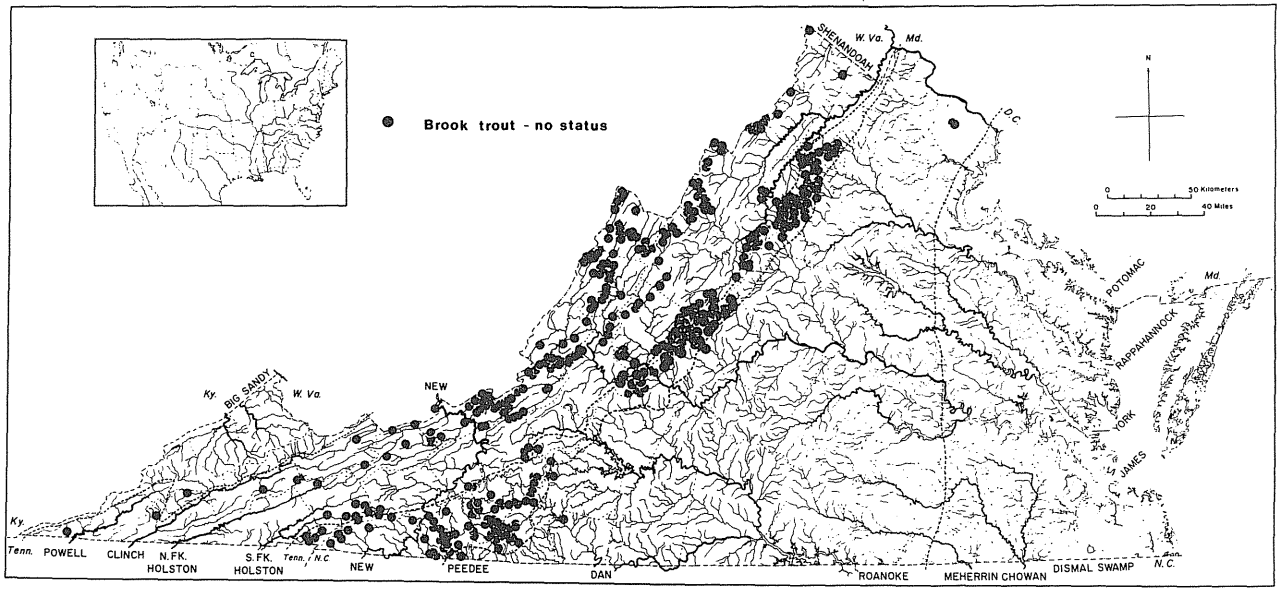


Figure 6. Records of brook trout, status unwarranted; range in extreme western part of state incompletely surveyed

Literature Cited

Anon. 1967. Clinch River Fish Kill, June 1967. Fed. Water Pollution Admin., Mid. Atl. Region, U.S. Dept. Interior. 20 p.

____. 1974a. Laws of Virginia Relating to Fisheries of Tidal Water. Reprinted from the Code of Virginia of 1950 and the 1974 Cumulative Suppl., Mar. Resour. Comm., Newport News, Virginia. 170 p.

____. 1974b. Endangered vertebrates of Virginia. Va. Wildl. 35(9):13-15, 18.

Bailey, J. R. 1977. Freshwater Fishes. Pp. 165-298 *In:* J. E. Cooper, S. S. Robinson and J. B. Funderberg, Editors. Endangered and Threatened Plants and Animals of North Caolina. N.C. State Mus. Nat. Hist., Raleigh.

Bailey, R. M. 1959. *Etheostoma acuticeps*, a new darter from the Tennessee River system, with remarks on the subgenus *Nothonotus*. Occ. Pap. Mus. Zool. Univ. Mich., No. 603, 10 p.

Beckham, E. C. 1977. A new species of darter in the subgenus *Alvordius* (genus *Percina)* from the upper New River drainage in North Carolina, Virginia, and West Virginia. Abst. 57th Annu. Meeting, Amer. Soc. Ichthyol. Herpetol. (unpaginated).

Behnke, R. J. 1972. The rationale of preserving genetic diversity. Proc. West. Assoc. State Game and Fish Comm. 52:559-561.

Borodin, N. 1925. Biological observations on the Atlantic sturgeon *(Acipenser sturio)*. Trans. Amer. Fish. Soc. 55:184-190.

Boyle, R. H. 1969. The Hudson River, a Natural and Unnatural History. W. W. Norton Co., Inc., New York. 304 p.

Burton, G. W. and E. P. Odum. 1945. The distribution of stream fish in the vicinity of Mountain Lake, Virginia. Ecology 26(2):182-194.

Buth, D. G. 1977. Biochemical identification of *Moxostoma rhothoecum* and *M. hamiltoni*. Biochem. Syst. Ecol. 5:57-60.

Byrne, D. M. 1976. Life History of the Spotfin Killifish *Fundulus luciae* (Pisces: Cyprinodontidae) in Fox Creek Marsh, Virginia. M. Sci. Thesis, College of William and Mary, Williamsburg, Virginia. 56 p.

Cairns, J., Jr., J. S. Crossman, K. L. Dickson, and E. E. Herricks. 1971. The recovery of damaged streams. Bull. Assoc. Southeast Biol. 18(3):79-106.

Clay, W. M. 1975. The Fishes of Kentucky. Ky. Dept. Fish Wildl. Resour., Frankfort. 416 p.

Collette, B. B. 1962. The swamp darters of the subgenus *Hololepis* (Pisces: Percidae). Tulane Stud. Zool. 9(4):115-211.

Comiskey, C. E. and D. A. Etnier. 1972. Fishes of the Big South Fork of the Cumberland River. J. Tenn. Acad. Sci. 47(4):140-145.

Cope, E. D. 1868. On the distribution of freshwater fishes in the Allegheny region of southwestern Virginia. J. Acad. Nat. Sci. Phila., Series 2, 6:207-247.

Crossman, J. A., J. Cairns, Jr., and R. L. Kaesler. 1973. Aquatic Invertebrate Recovery in the Clinch River Following Hazardous Spills and Floods. Va. Water Resour. Center Bull. 63. 66 p.

Dahlberg, M. D. and D. C. Scott. 1971. The freshwater fishes of Georgia. Bull. Ga. Acad. Sci. 29:1-64.

Denoncourt, R. F. 1969. A Systematic Study of the Gilt Darter *Percina evides* (Jordan and Copeland) (Pisces: Percidae). Ph.D. Thesis, Cornell Univ., Ithaca, New York. 216 p.

Denoncourt, R. F., E. C. Raney, C. H. Hocutt and J. R. Stauffer. 1975. A checklist of the fishes of West Virginia. Va. J. Sci. 26(3):117-120.

Eddy, S. 1969. How to Know the Freshwater Fishes. Edition 2. W. C. Brown Co., Dubuque, Iowa. 286 p.

Evermann, B. W. and S. F. Hildebrand. 1916. Notes on the fishes of east Tennessee. Bull. Bur. Fish. 34:431-451.

Fava, J. A., Jr. and C. Tsai. 1974. The life history of the pearl dace, *Semotilus margarita*, in Maryland. Chesapeake Sci. 15(3):159-162.

Gibbs, R. H., Jr. 1963. Cyprinid fishes of the subgenus *Cyprinella* of *Notropis*. The *Notropis whipplei - analostanus - chloristius* complex. Copeia (3):511-528.

Gilbert, C. R. 1961. *Notropis semperaspier*, a new cyprinid fish from the upper James River system, Virginia. Copeia (4):450-456.

_____. 1969. Systematics and distribution of the American cyprinid fishes *Notropis ariommus* and *Notropis telescopus*. Copeia (3):474-492.

Goode, G. B. 1884. The Fisheries and Fishery Industries of the United States. Section I. Natural History of Useful Aquatic Animals, Plates. U.S. Comm. Fish and Fish., Washington, D.C. 227 p.

Gorham, S. W. and D. E. McAllister, 1974. The shortnose sturgeon, *Acipenser brevirostrum*, in the Saint John River, New Brunswick, Canada, a rare and possibly endangered species. Syologeus 5, 18 p.

Graham, J. H. 1977. Factors affecting the distribution of sunfishes (Centrarchidae) in southern New Jersey. Abst. 57th Annu. Meeting, Amer. Soc. Ichthyol. Herpetol. (unpaginated).

Hambrick, P. S. 1973. Composition, Longitudinal Distribution and Zoogeography of the Fish Fauna of Back Creek, Blackwater River and Pigg River, tributaries of the Roanoke River in south-central Virginia. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg. 96 p.

Hambrick, P. S., R. E. Jenkins and J. H. Wilson. 1975. Distribution, habitat and food of the cyprinid fish *Phenacobius teretulus*, a New River drainage endemic. Copeia (1):172-176.

Hildebrand, S. F. and W. C. Schroeder. 1928. Fishes of Chesapeake Bay. Bull. U.S. Bur. Fish 63(1). 366 p.

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 Annu. Conf. Southeast. Assoc. Game and Fish Comm. (1974):398-413.

Hoff, J. G. 1965. Two shortnose sturgeon, *Acipenser brevirostris*, from the Delaware River, Scuder's Fall, New Jersey. Bull, N.J. Acad. Sci. 10)2):23.

Hoffman, R. L. 1969. The biotic regions of Virginia. Va. Poly. Inst., Res. Div. Bull. 48:23-62.

Holland, B. F. and G. F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. N. C. Dept. Nat. Econ. Resour., Spec. Sci. Rept. 24. 132 p.

Howell, J. F., Jr. 1971. The Life History, Behavior, and Ecology of *Percina aurantiaca* (Cope). Ph.D. Diss., University of Tennessee, Knoxville. 110 p.

Hubbs, C. L. and J. D. Black. 1940. Percid fishes related to *Poecilichthys variatus*, with descriptions of three new forms. Occ. Pap. Mus. Zool. Univ. Mich. No. 416, 36 p.

Hubbs, C. L. and E. C. Raney. 1947. *Notropis alborus*, a new cyprinid fish from North Carolina and Virginia. Occ. Pap. Mus. Zool. Univ. Mich. No. 498, 19 p.

Hubbs, C. L. and M. B. Trautman. 1932. *Poecilichthys osburni*, a new darter from the upper Kanawha River system in Virginia and West Virginia. Ohio J. Sci. 32:(1)31-88.

Huff, J. A. 1975. Life history of Gulf of Mexico sturgeon *Acipenser oxyrhynchus desotoi*, in Suwanee River, Florida. Fla. Mar. Res. Publ. 16, 32 p.

Hynes, H. B. N. 1970. The Ecology of Running Waters. Univ. Toronto Press. 555 p.

Jackson, H. W. and C. Henderson. 1942. A study of the stream pollution problem in the Roanoke, Virginia metropolitan district. Part 2. Macroscopic invertebrate and vertebrate faunae. The Toxicity of viscose wastes to fishes. Bull. Va. Polytech. Inst., Eng. Exp. Sta., Ser. 51, Vol. 35, No. 10, p. 91-120.

Jenkins, R. E. 1970. Systematic Studies of the Catostomid Fish Tribe Moxostomatini. Ph.D. Thesis, Cornell University, Ithaca, New York. 799 p.

_____. 1975a. (Untitled). Report on distribution, biology and status of *Hybopsis monacha*, spotfin chub. Rep. to Off. Endangered Species and Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 20 p.

_____. 1975b. (Untitled). Report on distribution, biology and status of *Noturus flavipinnis*, yellowfin madtom. Rep. to Off. Endangered Species and Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 11 p.

_____. 1975c. (Untitled). Report on distribution, biology and status of *Hybopsis cahni*, slender chub. Rep. to Off. Endangered Species Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 13 p.

_____. 1977a. (Untitled). Report on distribution, biology and status of *Percina rex*, Roanoke logperch. Rep. to Off. Endangered Species and Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 27 p.

_____. 1977b. (Untitled). Report on distribution, biology and status of *Noturus gilberti*, orangefin madtom. Rep. to Off. Endangered Species and Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 30 p.

_____. 1977c. (Untitled). Report on distribution, biology and status of *Moxostoma hamiltoni*, rustyside sucker. Rep. to Off. Endangered Species and Internat. Activities, U.S. Fish Wildl. Serv., Washington, D.C. 21 p.

Jenkins, R. E. and N. M. Burkhead. 1973. Distribution and habitat of the fishes in Copper Creek, a Clinch River tributary, Virginia. Bull. Assoc. Southeast. Biol. 20(2):61.

_____. 1975a. Distribution and aspects of life history and morphology of the cyprinid fish *Notropis semperasper* endemic to the upper James River drainage, Virginia. Chesapeake Sci. 16(3):178-191.

_____. 1975b. Recent capture and analysis of the sharphead darter, *Etheostoma acuticeps*, an endangered percid fish of the upper Tennessee River drainage. Copeia (4):731-740.

Jenkins, R. E., N. M. Burkhead and D. J. Jenkins. 1976. An ichthyologist looks at Virginia. Va. Wildl. 37(7):20-22.

Jenkins, R. E. and C. H. Freeman. 1972. Longitudinal distribution and habitat of the fishes of Mason Creek, an upper Roanoke River drainage tributary, Virginia. Va. J. Sci. 23(4):194-202.

Jenkins, R. E., E. A. Lachner and F. J. Schwartz. 1972. Fishes of the central Appalachian drainages: Their distribution and dispersal. Pp. 43-117 *In:* P. C. Holt (editor). The Distributional History of the Biota of the Southern Appalachians. Part III. Vertebrates. Virginia Polytechnic Institute and State University Research Division Monograph 4.

Jenkins, R. E., L. A. Revelle and T. Zorach. 1975. Records of the blackbanded sunfish, *Enneacanthus chaetodon*, and comments on the southeastern Virginia ichthyofauna. Va. J. Sci. 26(3):128-134.

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 regions. Bull. U.S. Fish Comm. 8:97-173.

Jordan, D. S. and B. W. Evermann. 1900. The fishes of North and Middle America. Bull. U.S. Nat. Mus. 47(4):3137-3313. Pls. 1-392.

Lachner, E. A. and R. E. Jenkins. 1971. Systematics, distribution, and evolution of the chub genus *Nocomis* Girard (Pisces: Cyprinidae) of eastern United States, with descriptions of new species. Smithsonian Contrib. Zool. 85. 97 p.

Lee, D. S., A. Norden, C. R. Gilbert and R. Franz. 1976. A list of the freshwater fishes of Maryland and Delaware. Chesapeake Sci. 17(3):205-211.

MacCrimmon, H. R. and J. S. Campbell. 1969. World distribution of brook trout, *Salvelinus fontinalis*. J. Fish. Res. Bd. Can. 26(7):1699-1725.

MacCrimmon, B. L. Gots and J. S. Campbell. 1971. World distribution of brook trout, *Salvelinus fontinalis:* Further observations. J. Fish. Res. Bd. Can. 28(3):452-456.

Masnik, M. T. 1974. Composition, Longitudinal Distribution, and Zoogeography of the Fish Fauna of the Upper Clinch System in Tennessee and Virginia. Ph.D. Thesis, Virginia Polytechnic Institute and State University, Blacksburg. 401 p.

McAtee, W. L and A. C. Weed. 1915. First list of the fishes of the vicinity of Plummers Island, Maryland. Proc. Biol. Soc. Wash. 28:1-14.

McGauhey, P. H. and H. F. Eich. 1942. A study of the stream pollution problem in the Roanoke, Virginia, metropolitan district. Part 1. Physical and chemical tests of waters. Sanitary bacteriological examination of waters. The plankton of the waters and muds. Bull. Va. Polytech. Inst. Eng. Exp. Sta., Ser. 51, Vol. 35(10):1-90.

McLeod, M. J. and J. D. Moore. 1978. Change in the gastropod *Io spinosa* (Pleuroceridae: Mollusca) in 70 years. Amer. Midl. Nat. 99(1):198-205.

Menhinick, E. F., T. M. Burton and J. R. Bailey. 1974. An annotated checklist of the freshwater fishes of North Carolina. J. Elisha Mitchell Sci. Soc. 90:24-50.

Menzel, B. W. and M. S. Boyce. 1973. First record of the pearl dace, *Semotilus margarita*, from Iowa. Iowa State J. Res. 47(4):245-248.

Miller, R. R. 1955. An annotated list of the American cyprinodontid fishes of the genus *Fundulus*, with the description of *Fundulus persimilis* from Yucatan. Occ. Pap. Mus. Zool. Univ. Mich. No. 568. 27 p.

_____. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2):239-252.

Minckley, W. L. and J. E. Craddock. 1962. A new species of *Phenacobius* (Cyprinidae) from the upper Tennessee River system. Copeia (2):369-377.

Murawski, S. A. and A. L. Pacheco. 1977. Biological and fisheries data on Atlantic Sturgeon, *Acipenser oxyrhynchus* Mitchell. Sandy Hook Lab., Northeast Fish. Center, Nat. Mar. Fish. Serv. Tech. Rept. 10. 69 p.

Musick, J. M. 1972. Fishes of Chesapeake Bay and the Adjacent Coastal Plain. Pp. 175-212 *In:* M. L. Wass (editor). A Check List of the Biota of Lower Chesapeake Bay. Va. Inst. Mar. Sci., Spec. Sci. Rept. No. 65, Gloucester Pt.

Page, L. M. 1974. The subgenera of *Percina* (Percidae: Etheostomatini). Copeia (1): 66-86.

_____. 1975a. The life history of the stripetail darter, *Etheostoma kennicotti*, in Big Creek, Illinois. Ill. Nat. Hist. Surv. Biol. Notes No. 93. 15 p.

_____. 1975b. Relations among the darters of the subgenus *Catonotus* of *Etheostoma*. Copeia (4):782-784.

Pflieger, W. L. 1975. The Fishes of Missouri. Missouri Dept. Conserv. 343 p.

Raleigh, R. F., D. H. Bennett, L. O. Mohn and O. E. Maughan. 1978. Changes in fish stocks after major fish kills in the Clinch River near St. Paul, Virginia. Amer. Midl. Nat. 99(1):1-9.

Ramsey, J. S. 1976. Freshwater fishes. Pp. 53-65 *In:* H. Boschung (editor). Endangered and Threatened Plants and Animals of Alabama. Bull. Ala. Mus. Nat. Hist. No. 2.

Raney, E. C. 1950. Freshwater fishes. Pp. 151-194 *In:* The James River Basin--Past, Present and Future. Va. Acad. Sci., Richmond.

Raney, E. C. and E. A. Lachner. 1946. *Thoburnia hamiltoni*, a new sucker from the upper Roanoke River system in Virginia. Copeia (4):218-226.

Reno, H. W. 1969. Cephalic lateral-line systems of the cyprinid genus *Hybopsis*. Copeia (4):736-773.

Ross, R. D. 1959. Game fish streams and records of fishes from the Potomac-Shenandoah River system of Virginia. Va. Agr. Exp. Sta. Tech. Bull. 140. 20 p.

_____. 1969. Drainage evolution and fish distribution problems in the Southern Appalachians of Virginia. Pp. 277-292 *In:* P. C. Holt (editor). The Distributional History of the Biota of the Southern Appalachians. Part 1: Invertebrates. Virginia Polytechnic Institute Research Division Mongraph 1.

_____. 1972a. The drainage history of the Tennessee River. Pp. 11-42 *In:* P. C. Holt (editor). The Distributional History of the Biota of the Southern Appalachians. Part III. Vertebrates. Virginia Polytechnic Institute and State University Research Division Monograph 4.

_____. 1972b. Fish studies. Pp. 21-30 *In:* J. Cairns, Jr. and K. L. Dickson. An ecosystematic study of the South River, Virginia. Va. Water Resour. Center Bull. 54.

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 p.

Ryder, J. A. 1890. The sturgeons and sturgeon industries of the eastern coast of the United States, with an account of experiments bearing upon sturgeon culture. Bull. U.S. Fish Comm. (1888). 8:231-328.

Saylor, C. F. and D. A. Etnier. 1976. Rediscovery of the sharphead darter, *Etheostoma acuticeps* Bailey, in the lower Nolichucky River, Tennessee. Bull. Assoc. Southeast Biol. 23(2):93.

Schuder, G. D. 1977. Limestone stream renaissance in the Old Dominion: Mossy Creek. Trout 18(3):20-24.

Schultz, L. P. 1939. The freshwater fishes of Virginia. Explorations and Field Work of the Smithsonian Institution in 1938, p. 55-58.

Scott, W. B. and E. J. Crossman. 1973. Freshwater Fishes of Canada. Fish. Res. Bd. Can. Bull. 184. 966 p.

Sherrard, J. H. and J. L. Hoyle. 1977. A productivity study of the Roanoke River above Niagra Dam in Virginia. Va. Water Resour. Res. Center Bull. 104. 65 p.

Smith, H. M. and B. A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Bull. U.S. Fish Comm. 18:179-187.

Smith, P. W. 1971. Illinois streams: A classification based on their fishes and an analysis of factors responsible for disappearance of native species. Ill. Nat. Hist. Surv., Biol. Notes 76. 14 p.

Smith, W. B. 1971. The biology of the Roanoke bass. N.C. Wildl. Resour. Comm., Raleigh (Final Rept., Fed. Aid in Fish Restoration Proj. F-19). 31 p.

Stauffer, J. R., C. H. Hocutt, M. T. Masnik and J. E. Reed, Jr. 1975. The longitudinal distribution of the fishes of the East River, West Virginia-Virginia. Va. J. Sci. 26(3):121-125.

Taylor, W. R. 1969. A revision of the catfish genus *Noturus* Rafinesque with an analysis of higher groups in the Ictaluridae. U.S. Nat. Mus. Bull. 282. 315 p.

Taylor, W. R., R. E. Jenkins and E. A. Lachner. 1971. Rediscovery and description of the ictalurid catfish, *Noturus flavipinnis*. Proc. Biol. Soc. Wash. 83(41): 469-476.

Thompson, B. A. 1972. Systematics and distribution of the tangerine darter, *Percina aurantiaca* (Cope), Family Percidae, tribe Etheostomatini. Abst. 52nd Annu. Meeting Amer. Soc. Ichthyol. Herpetol. (unpaginated).

Trautman, M. B. 1957. The Fishes of Ohio. Ohio State Univ. Press, Columbus. 683 p.

Trautman, M. B. and D. K. Gartman. 1974. Re-evaluation of the effects of man-made modifications on Gordon Creek between 1887 and 1973 and especially as regards its fish fauna. Ohio J. Sci. 74(3):162-173.

Trojnar, J. R. and R. J. Behnke. 1974. Management implications of ecological segregation between two introduced populations of cutthroat trout in a small Colorado Lake. Trans. Amer. Fish. Soc. 103(3):423-430.

Uhler, P. R. and O. Lugger. 1876. List of fishes of Maryland. Md. Comm. Fish. Rep. (1876):67-176.

Vladykov, V. D. and J. R. Greeley. 1964. Order Acipenseroidei. Pp.24-60 *In:* Fishes of the western North Atlantic. Sears Found. Mar. Res. 1(3). (year 1963 given on title page).

Wiley, M. L. 1970. Fishes of the lower Potomac River. Atl. Naturalist 25(4):151-159.

Zorach, T. 1969. *Etheostoma jordani* and *E. tippecanoe*, species of the subgenus *Nothonotus* (Pisces: Percidae). Amer. Midl. Nat. 81(2):412-434.

Zorach, T. 1972. Systematics of the percid fishes, *Etheostoma camurum* and *E. Chlorobranchium* new species, with a discussion of the subgenus *Nothonotus*. Copeia (3):427-447.

Zorach, T. and E. C. Raney. 1967. Systematics of the percid fish, *Etheostoma maculatum* Kirtland, and related species of the subgenus *Nothonotus*. Amer. Midl. Nat. 77(2):296-322.