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A Survey of Fish Communities of Streams in Coal Surface Mining Areas of the Cumberland Plateau, Tennessee

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from the Green River at SR 88, Green Co., Kentucky, in company with 17 other species including Hybopsis dissimilis, Phenacobius uranops, Noturus eleutherus, Etheostoma bellum, Etheostoma rafinesquei, Percina copelandi and Percina evides.

81. Etheostoma variatum Kirtland - variegate darter.
Collections: 3, 7, 10-11, 13, 15, 17, 19-21, 23, 26-27. This colorful fish typically lives in deep, swift riffles over a large-rock substrate. Previous records: Woolman (1892), Turner (1967), Jones (1973), Harker et al (1979), Gilbert in Lee et al (1980) (mapped) - numerous localities.

82. Etheostoma zonale (Cope) - banded darter.
Collections: 3-5, 15-21, 23, 26-27. Previous records: Woolman (1892), Turner (1967), Jones (1973), Harker et al (1979), Denoncourt in Lee et al (1980) (mapped) - numerous localities.

83. Percina caprodes caprodes (Rafinesque) - central logperch.
Collections: 3-4, 7, 12, 14-15, 17, 19-20, 27. Previous records: Charles (1967), Turner (1967), Jones (1973), Thompson in Lee et al (1980) (mapped) - numerous localities.

84. Percina copelandi Jordan - channel darter. Special Concern.
Collections: 4(2), 5(2), 7(11), 16(2), 17(2). There are few records for the channel darter through eastern Kentucky in general and the upper Kentucky River drainage in particular. Previous records: Turner (1967) - Greasy Cr., Leslie Co.; Middle Fk., Leslie-Perry cos. (also see Clay 1975); Gilbert and Burgess in Lee et al (1980) (mapped) - Middle Fork system. Our specimens are currently being studied by Dr. Royal Suttkus, Tulane University.

85. Percina (Odontopholis) n. sp. cf cymatotaenia (Gilbert and Meek) - bluestripe darter. Special Concern.
Collections: 3(1). The only other record for this species is that of Harker et al (1979) from the mouth of Sturgeon Creek, Lee Co.

86. Percina evides (Jordan and Copeland) - gilt darter. Special Concern.
Collections: 5, 7. The gilt darter is of sporadic occurrence in the upper Kentucky River drainage. The only other published record from the Middle Fork system is that of Turner (1967), Perry Co. (also see Clay [1975] and Denoncourt in Lee et al [1980]).

87. Percina maculata (Girard) - blackside darter.
Collections: 1, 13, 17, 21, 23, 26. Previous records: Turner (1967), Jones (1973), Harker et al (1979), Beckham in Lee et al (1980) (mapped) - numerous localities.

88. Percina oxyrhyncha (Hubbs and Raney) - sharpnose darter. Status undetermined.
Collections: none. Previous records: Turner (1967) reported Percina phoxocephala from Greasy Cr., Leslie Co., and Middle Fork in Perry and Breathitt cos. However, Bruce Turner, Tulane University, has determined that all material from the upper Kentucky River is the present species. The status listed above probably should be changed to Threatened.

89. Percina sciera (Swain) - dusky darter.
Collections: 5(7), 7(1), 17(2). The only other published records (included by Page in Lee et al [1980]) are those by Turner (1967) from Greasy Creek, Leslie Co., and the Middle Fork, Leslie-Breathitt cos.

Family Sciaenidae (Drums)

90. Aplodinotus grunniens (Rafinesque) - freshwater drum.
Collections: 17(1). This large-stream fish was previously reported from Buckhorn Reservoir (Charles 1967, Turner 1967) and the Middle Fork, Perry and Lee cos. (Jones 1973).

Family Cottidae (Sculpins)

91. Cottus carolinae (Gill) - banded sculpin.
Collections: 22(3). Although Lee in Lee et al (1980) listed the banded sculpin from the Middle Fork, we were unable to locate any other published references to the species from that system.

Acknowledgments

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A SURVEY OF FISH COMMUNITIES OF STREAMS IN COAL SURFACE MINING AREAS OF THE CUMBERLAND PLATEAU, TENNESSEE

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Introduction

Coal, the most abundant and economically feasible energy source in the United States, has been labelled the resource to fulfill the energy needs of today's society. Coal production is expected to increase by 65 to 85 percent above the production level of 1975 by the year 1985 (Yancik 1979).

Increased production of coal leads to a greater stress on the aquatic environment due to the influx of acid mine drainage (AMD) and silt. AMD is a product of both surface and underground mining, but is an extremely serious problem in surface mining. It is formed by the oxidation of pyritic material found in the strata surrounding the coal seam and will result in the lowering of the pH, increasing iron concentration and the formation of a sterile ferric hydroxide (FeOH) slime or "yellowboy" on the substrate (Barnes and Romberger 1969).

Siltation resulting from surface mining also has a serious impact on the lotic environment. Increases in silt have been found to decrease benthic macroinvertebrate communities, thus affecting the ichthyofauna of a stream. Although the influx of AMD and silt are the major degrading factors of coal mining, increased heavy metal concentrations and coal mines also have been found to severely affect the aquatic environment.

Many studies have depicted the detrimental effects of coal mining. Vaughan (1979) found that diatoms and fish species diversities were reduced in streams receiving AMD. Koryak et al (1972) reported that riffle zoobenthos were affected adversely and their community structure was altered radically. Branson and Batch (1972) noted changes in fish communities due to siltation from surface mining, and concluded that fish were eliminated or forced to emigrate because of the loss of a food source or reduction in their reproductive capabilities. Wilson et al (1981) found increased heavy metal concentrations in the livers of rainbow trout (Salmo gairdneri) and brown trout (Salmo trutta) in streams receiving AMD.

The purpose of our study was two-fold: First, to determine the effects of varying degrees of coal mining activities on the ichthyofauna of selected streams; and second, to attempt to identify streams that should be considered environmentally sensitive by state and federal agencies. The criteria for these streams is the occurrence of endangered, threatened, or specially concerned species as determined by the Tennessee Heritage Program, or a rich ichthyofauna in watersheds in which the majority of streams are heavily impacted.

Study Area

The Cumberland Plateau region of Tennessee is part of the Applachian Plateau physiographic province of eastern United States, which extends from the southern border of New York to central Alabama (Luther 1959). The plateau is a broad, flat-topped tableland capped primarily with sandstone of Pennsylvanian geological age. The surface elevation of the plateau is usually between 1,700 and 2,000 feet above sea level.

A number of the streams sampled are adjacent to the plateau. The Sequatchie River and the Little Sequatchie River flow through a large, broad valley in southeastern Tennessee. This valley is bordered on both sides by the plateau. The Wolf River, West Fork of Obey River, and Elk River originate on the plateau, but cascade onto the Eastern Highland Rim. The rim is of Mississippian geological age and constituted primarily of a limestone conglomerate (Luther 1959).

All streams are in the Tennessee or Cumberland river drainages. Major systems within the Tennessee drainage include the Clinch and Powell rivers, whereas those in the Cumberland drainage include the Big South Fork, Caney Fork, Clear Fork, and Obey River.

Materials and Methods

Fish were collected by electrofishing, seining, and ichthyocide application during the fall of 1980. A section of the steam was enclosed and the appropriate sampling technique applied. Fish were preserved in 10% formalin and returned to the laboratory for identification, using the taxonomic keys of Pflieger (1975), Clay (1975), and Etnier (unpublished).

The degree of coal mining impact was determined subjectively, and was based primarily on fish species and benthic macroinvertebrate richness (from qualitative samples), in comparison to drainage area and fauna to be expected at each site. (See subsequent discussion in Results and Discussion section). We determined drainage area and fish species richness, whereas benthic macroinvertebrate data are from Pennington (1980). Using this system, streams were ranked on a scale from 1 to 10, with 1 the most heavily impacted and 10 the least. The most pronounced break in faunal richness appears between those streams in categories 4 and 5.

Selected samples of certain species have been deposited in the fish collections at Tennessee Technological University or at the University of Tennessee, as indicated in Table 1.

Collection Sites

Twenty-three collection sites are listed and referenced by site number, river drainage, locality, county, and the drainage area. Species collected at each site are indicated by number and referenced in Table 1. Species richness is also listed.

1. Sequatchie River (Tennessee R.), 24 km E of Whitwell, Marion Co.; 1603.7 km^2. Species: 3,6,8-9,13,16,22-23,25,35,37,39-40,43,51,53,56, 62. Species richness: 18.
2. Clear Fork (Big South Fork of Cumberland R.), 5.3 km NW of Robbins; Scott Co.; 703.5 km^2. Species: 3,9,14,16,22-24,34,36-37,39,43-44, 49,60. Species richness: 15.
3. Little Sequatchie River (Tennessee R.), State Highway 27 bridge, Marion Co.; 300.9 km^2. Species: 3,6,13-14,18,20,22-23,25,34,36-37, 43-44,46,51,61-62. Species richness: 18.
4. Wolf River (Obey R.), 5.1 km E of Byrdstown, Pickett Co.; 275.0 km^2. Species: 3,14,22-24, 28-29,34,36-39,41-42,47,54,57. Species richness: 17.
5. White Oak Creek (Big South Fork of Cumberland R.), State Highway 52 bridge at Rugby, Morgan Co.; 266.5 km^2. Species: 10-11,13-14,17,19, 23,34,36-37,39,43-44,57,58. Species richness: 15.
6. Poplar Creek (Clinch R.), 1.9 km NW of State Highway 95, Anderson Co.; 214.0 km^2. Species: 2,35,59. Species richness: 3.
7. West Fork of the Obey River (Obey R.), State Highway 52 bridge at Alpine, Overton Co.; 183.7 km^2. Species: 6,7,14,17-19,23-24,29, 33-34,37,39,40,42-44,50-51,54,57. Species richness: 21.
8. Elk River (Tennessee R.), State Highway 41 bridge at Pelham, Grundy Co.; 170.2 km^2. Species: 2,3,10,13-15,20,23,26,31,34-35,43, 46-47,53-54,57,62. Species richness: 19.
9. Piney River (Tennessee R.), 3.2 km NW of Spring City, Rhea Co.; 161.6 km^2. Species: 12,14,18, 34,39,43,49,51,53. Species richness: 9.
10. Richland Creek (Tennessee R.), 1.6 km NW of Dayton, Rhea Co.; 130.2 km^2. Species: 3,13, 23,28,34,36-37-39,41,44,47,51,53,57. Species richness: 15.
11. Soddy Creek (Tennessee R.), 1.3 km N of Soddy, Hamilton Co.; 127.1 km^2. Species: 22,35. Species richness: 2.
12. Stinking Creek (Clear Fork of Cumberland R.), at Stinking Creek School, Campbell Co.; 99.4 km^2. Species: 3,20-23,48,52. Species richness: 7.
13. East Fork of Obey River (Obey R.), 1.4 km W of Cliff Springs, Overton Co.; 98.8 km^2. Species: none. Species richness: 0.
14. Davis Creek (Powell R.), 0.5 km S of Old State Highway 63 near Speedwell. Claiborne Co.; 80.9 km^2. Species: 3,9,10,12,18,20. Species richness: 6.
15. Jellico Creek (Clear Fork of Cumberland R.), bridge at Gum Fork Road near Newcomb, Campbell Co.; 73.2 km^2. Species: 3,20,22-23,25,34, 36,40,48,52,58. Species richness: 11.
16. Beech Fork (Big South Fork of Cumberland R.), bridge at Shea, Campbell Co.; 72.4 km^2. Species: 3,10,14,16-17,23,25,36,43-45,58. Species richness: 12.
17. Elk River (Tennessee R.), 7.1 km NW of Pelham, Grundy Co.; 66.7 km^2. Species: 1,3,5,22-23, 25,32,36,41,45-46,62. Species richness: 12.
18. Coal Creek (Clinch R.), U.S. Highway 25 W bridge near Lake City, Anderson Co.; 63.6 km2. Species: 3,4,28,30,34,36,38. Species richness: 7.
19. Cove Creek (Clinch R.), 0.8 km N of Caryville; Campbell Co.; 61.7 km^2. Species: 3,13-14,21,23,25,33,36,39,43,51,53. Species richness: 12.
20. Smoky Creek (Big South Fork of the Cumberland R.), 7.6 km SW of Smoky Junction, Scott Co.; 44.6 km^2. Species: 3,16-17,22-23,25,37,40, 43-44,55,57-58. Species richness: 13.
21. Bee Creek (Caney Fork of Cumberland R.), Lantana Road bridge, 0.6 km W of Winesap, Cumberland Co.; 43.8 km^2. Species: 3,22,36. Species richness: 3.
22. Crooked Creek (Big South Fork of Cumberland R.), 2.6 km W of Allardt, Fentress Co.; 9.38 km^2. Species: 13,27,36,39. Species richness: 4.
23. Long Branch (Big South Fork of Cumberland R.), 2.3 km E of Grimsley, Fentress Co.; 2.87 km^2. Species: 22. Species richness: 1.

Results and Discussion

To determine the degree of impact that coal mining activities have on the lotic environment, a number of factors were considered. Although drainage area cannot always be positively correlated with fish species richness (as in instances of isolation), a general trend does exist. By utilizing this correlation, as well as benthic macroinvertebrate data as previously described, a subjective ranking of streams was acquired (Table 2).

Certain natural factors may also affect fish diversity within an area. For example, streams on the Cumberland Plateau (i.e. those situated on Pennsylvanian limestone strata that have not cut down to Mississippian limestone) naturally tend to be relatively depauperate, even when pristine. Stream order and the complexity and drainage area of a system also are important when considering species composition and richness. Horton (1945) discussed steam order, and classified streams on the basis of dentritic patterns. His classification takes into consideration the complexity of the watershed but not the drainage area, although there is a positive correlation between the two. Keuhne (1962) found a positive correlation between increasing stream order and fish species richness. This principle is generally accepted by aquatic biologists, but in streams receiving AMD runoff the species richness does not follow this correlation.

The East Fork of the Obey River (Site 13) and Soddy Creek (Site 11) are the most severely affected of all the study sites. Most streams were moderately impacted, having benthic macroinvertebrate species richness of between 21 and 36 and fish species richness from 6 to 19. The Little Sequatchie River (Site 3) and Wolf River (Site 4) were the least impacted of the study areas.

A total of 62 species were collected, representing 11 families (Table 1). The most common of these included Campostoma anomalum (central stoneroller), Semotilus atromaculatus (creek chub), Hypentelium nigricans (northern hog sucker), and Lepomis macrochirus (bluegill).

The creek chub is tolerant of AMD conditions, and frequently is the only species found in receiving streams (Branson and Batch 1972). It feeds primarily on terrestrial insects, and therefore is not entirely dependent on the aquatic food web. Matthews and Styron (1981) reported that headwater species such as Semotilus atromaculatus are tolerant of abrupt changes in the physicochemical environment. Parameters such as dissolved oxygen, temperature and pH were studied in their research, but it appears that AMD-induced changes also may be important in eliminating intolerant species and not Semotilus atromaculatus.

The central stoneroller and northern hog sucker are abundant throughout the Tennessee and Cumberland river drainages. Although they were found in streams receiving AMD, they were less tolerant of AMD than the creek chub. Their life histories are closely correlated with abiotic conditions in the streams, and they do not utilize terrestrial food sources.

Fish intolerant of AMD conditions included most of the percid species. The most abundant and widely distributed of these in the study area, Etheostoma blennioides (greenside darter) and Etheostoma caeruleum (rainbow darter) were not found in severely affected streams. These species are helpful when making comparisons, since they are found in both the Tennessee and Cumberland river drainages and utilize a wide range of environmental conditions. It appears that both food sources and spawning requirements are eliminated due to acid mine drainage (Branson and Batch 1972). These factors were the major reason for the elimination of most percids in severely affected streams.

Four species were collected during the survey that, because of the status accorded them by the Tennessee Heritage Program (Eagar and Hatcher 1980) or their general rarity in the state, merit discussion. Hemitremia flammea (flame chub) and Chologaster agassizi (spring cavefish) were both collected at site 17, which was accorded a habitat ranking of 5 (Table 2). The former was listed as a species of Special Concern, whereas the second is noteworthy because of its rather limited distribution in the southern part of the state. Both species are partial to cool, clear waters, and would be among the first to disappear with increased mining activity in the Elk River system. They are good indicator species that should be carefully monitored. Etheostoma sagitta (arrow darter), which was taken at sites 12 and 15, is regarded as threatened in Tennessee. Stinking Creek (site 12) was considered to be heavily impacted (habitat ranking of 2; Table 2), and the specimens of E. sagitta were collected on the few relatively silt-free riffles of this otherwise heavily silted creek. The future of the species in this creek is precarious. Jellico Creek (site 15) was accorded a habitat ranking of 5. Etheostoma baileyi (emerald darter) was taken in Smoky Creek, which is moderately impacted (ranking of 6). This species has been found to occupy a variety of habitats, and appears to be tolerant of such siltation as was present in Smoky Creek. Nevertheless, the species has a fairly limited distribution in Tennessee, and could be affected by increased coal mining activities.

Five streams are noted in Table 2 as environmentally sensitive, and should be of special concern to state and federal agencies. Of these, the Elk River, Jellico Creek, Stinking Creek, and Smoky Creek were discussed in the preceding paragraph. The fifth stream, Beech Fork, is unique in that it occurs in an otherwise decimated watershed. The New River watershed historically has been the major coal producing area of the state, and its aquatic life has suffered (Vaughan 1979). The relatively rich ichthyofauna in Beech Fork thus may serve as a reservoir if reclamation practices are implemented and conditions improve in adjacent streams.

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Table 1. A list of fish species collected at selected study sites.

Scientific Name	Study Sites*
1. *Salmo gairdneri*	17
2. *Dorosoma cepedianum*	6,8
3. *Campostoma anomalum*	1,2,3,4,8,10,12,14-21
4. *Cyprinus carpio*	18
5. *Hemitremia flammea*[a]	17
6. *Hybopsis amblops*	1,3,7
7. *Hybopsis dissimilis*	7
8. *Hybopsis insignis*	1
9. *Nocomis micropogon*	1,2,14
10. *Notropis ardens*	5,8,14,16
11. *Notropis ariommus*[a]	5
12. *Notropis coccogenis*[a]	9,14
13. *Notropis c. chrysocephalus*	1,3,5,8,10,19,22
14. *Notropis galacturus*	2-5,7-9,16,19
15. *Notropis lirus*	8
16. *Notropis rubellus*	1,2,16,20
17. *Notropis stramineus*	5,7,16,20
18. *Notropis telescopus*	3,7,9,14
19. *Notropis volucellus*[a]	5,7
20. *Pimephales notatus*	3,8,12,14,15
21. *Rhinichthys atratulus*	12,19
22. *Semotilus atromaculatus*	1-4,11,12,15,17,20,21,23
23. *Hypentelium nigricans*	1-5,7,8,10,12,15-17,19,20
24. *Moxostoma duquesnei*	2,4,7
25. *Moxostoma erythrurum*	1,3,15-17,19,20
26. *Moxostoma macrolepidotum*	8
27. *Ictalurus melas*	22

Table 1. (continued)

Scientific Name	Study Sites*
28. *Ictalurus natalis*	4,10,18
29. *Noturus flavus*	4,7
30. *Fundulus catenatus*	18
31. *Fundulus notatus*	8
32. *Chologaster agassizi*[a]	17
33. *Labidesthes sicculus*[a]	7,19
34. *Ambloplites rupestris*	2-5,7-10,15,18
35. *Lepomis cyanellus*	1,6,8,11,21
36. *Lepomis macrochirus*	2-5,10,15-19,22
37. *Lepomis megalotis*	1-5,7,10,20
38. *Lepomis microlophus*	4,18
39. *Micropterus dolomieui*	1,2,4,5,7,9,10,19,22
40. *Micropterus punctulatus*	1,7,10,15,20
41. *Micropterus s. salmoides*	4,10,17
42. *Etheostoma atripinne*[a]	4,7
43. *Etheostoma blennioides*	1-3,5,7-9,16,19,20
44. *Etheostoma caeruleum*	2,3,5,7,10,16,20
45. *Etheostoma camurum*	16,17
46. *Etheostoma duryi*[a]	3,8,17
47. *Etheostoma flabellare*[a]	4,8,10
48. *Etheostoma kennicotti*	12,15
49. *Etheostoma maculatum*[a]	2,9
50. *Etheostoma obeyense*	7
51. *Etheostoma rufilineatum*	1,3,7,9,10,19
52. *Etheostoma sagitta*[a]	12,15
53. *Etheostoma simoterum*[a]	1,8-10,19
54. *Etheostoma stigmaeum*[a]	4,7,8
55. *Etheostoma baileyi*	20
56. *Etheostoma zonale*	1
57. *Percina caprodes*	4,5,7,8,10,20
58. *Percina maculata*[a]	5,15,16,20
59. *Percina sciera*[a]	6
60. *Percina squamata*[b]	2
61. *Cottus bairdi*	3
62. *Cottus carolinae*	1,3,8,17

*reference numbers from collection sites

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RECENT COLLECTIONS OF FISHES FROM THE BIG SOUTH FORK OF THE CUMBERLAND RIVER SYSTEM, TENNESSEE AND KENTUCKY

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The Big South Fork of the Cumberland River (BSFCR) system originates with the confluence of the Clear Fork and the New River in Tennessee, and flows in a northerly direction for approximately 40 miles, until it reaches Lake Cumberland, Kentucky. The majority of the tributaries drain the Cumberland Plateau region, which is of Pennsylvanian geologic age. The main river and some larger tributaries have created a gorge, resulting in exposed strata of Mississippian geologic age (Luther 1959).

Comiskey (1970) studied the fishes of this system, and Comiskey and Etnier (1972) later formally published the results of this work, in which they summarized the limited number of earlier publications dealing entirely or in part with the fishes of the system (Cope 1870; Kirsch 1893; Fowler 1907, 1924; Evermann 1918; Shoup and Peyton 1940), and included lists of species recorded by each. They also provided an annotated list of all species known from the system (although they did not include specific locality data for most species), and discussed the probable method (man-induced) by which two species (*Etheostoma sagitta* and *E. kennicotti*) have reached the Big South Fork system from adjacent parts of the upper Cumberland drainage (i.e. above Cumberland Falls) to the east. The reader is referred to Comiskey and Etnier's 1972 paper for further information.

Recent studies have concentrated on degradation of the aquatic environment due to man's activities. Species distributions have become reduced by acid mine drainage, oil and natural gas field runoff, logging, and domestic and industrial pollution in many streams (Parsons 1959; Winger et al 1979; O'Bara et al 1982). Renewed interest in the BSFCR system has surfaced since establishment of the Big South Fork National River and Recreation area. This area comprises approximately 100,000 acres within the BSFCR system, and provides environmental protection for many tributaries.

The following report lists the results of collections made from 48 stations during the summer and fall of 1981. Only tributaries of the free-flowing section of the BSFCR were sampled, using a combination of 120-volt backpack electroshocker, seines, and ichthyocides. Three sampling sites were selected on