FISHES OF THE BUFFALO RIVER SYSTEM, WILKINSON COUNTY, SOUTHWESTERN MISSISSIPPI

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ABSTRACT

The occurrence and distribution of the fishes of the Buffalo River in southwestern Mississippi were determined from two major surveys conducted from 1968-1971 and 1986-1991, as well as museum and literature records. In all, 95 species, from 20 families and 50 genera, were documented from the Buffalo River system. Cyprinids, centrarchids, poeciliids, fundulids, and clupeids were numerically dominant in both surveys. Longitudinal distribution of fishes in Buffalo River showed progressive downstream addition, with a large-scale replacement in the lower reaches. Monthly collections were made at six permanent stations from September 1986 to October 1987. Community similarity indices revealed relatively low faunal similarity between upper and lower sections of Buffalo River, and a strong pattern of seasonal variation in the lower section of the river.

INTRODUCTION

The importance of the Mississippi River in fish biogeography has been discussed in detail (Guillory, 1978, 1982; Grady et al., 1983; Conner and Suttkus, 1986). Fishes have been surveyed in several tributaries to the eastern part of the Mississippi River in Mississippi and Louisiana (Guillory, 1981, 1982; Grady et al., 1983; Cashner et al., 1979; Grady and Cashner, 1988; Ebert et al., 1985; Matthews, 1978), but only a few of the detailed results of these surveys have been published.

Buffalo River (or Buffalo Bayou) is the lowermost eastern major tributary to the Mississippi River. Fish collections were made sporadically in the Buffalo River by R. D. Suttkus and students at Tulane University in the mid-1950's and early 1960's. The first comprehensive survey of the drainage was from November 1968 to July 1971, in which 68 collections were made at 17 sites located primarily in the upper and middle reaches of the river (Cashner et al., 1976). The present study included a second major survey conducted from September 1986 to November 1991. During this period, 140 collections were made

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at 60 different localities; 82 collections were made during monthly samples at 6 stations from September 1986 to October 1987. The two surveys represent a combined total of 208 collections at 60 localities. The purpose of this paper is to present a list of species for the Buffalo River drainage, to document the pattern of distribution of these species, and to assess seasonal variation in the fish assemblages at the six stations sampled monthly from 1986-1987. A paper currently in preparation will compare the results of the two major surveys and assess the changes in fish assemblages over a time span of nearly two decades.

Study Area

Except for extreme headwaters in Amite County, Buffalo River is within Wilkinson County, Mississippi (Figure 1). The spring-fed headwaters of the river originate in a forested area, 3.5 miles north of Centreville, Mississippi. The river flows in a westerly direction, then north, increasing in size to a 4th-order stream (based on Strahler, 1957) as it receives runoff from small creeks and its first major tributary, Little Buffalo River. Buffalo River continues to flow northward, gradually increasing in width and depth. Near the vicinity of the Mississippi Highway 563 bridge, the river starts a northwesterly course and continues in this direction until it divides into several channels and forms a series of bald cypress dominated swamps near Lessley, Mississippi. Then the river flows southwesterly to Lake Mary, an ox-bow lake formed from the Mississippi River, which is also connected to the Homochitto River to the north. After Lake Mary, Buffalo River flows nearly due south, entering the Mississippi River near River Mile

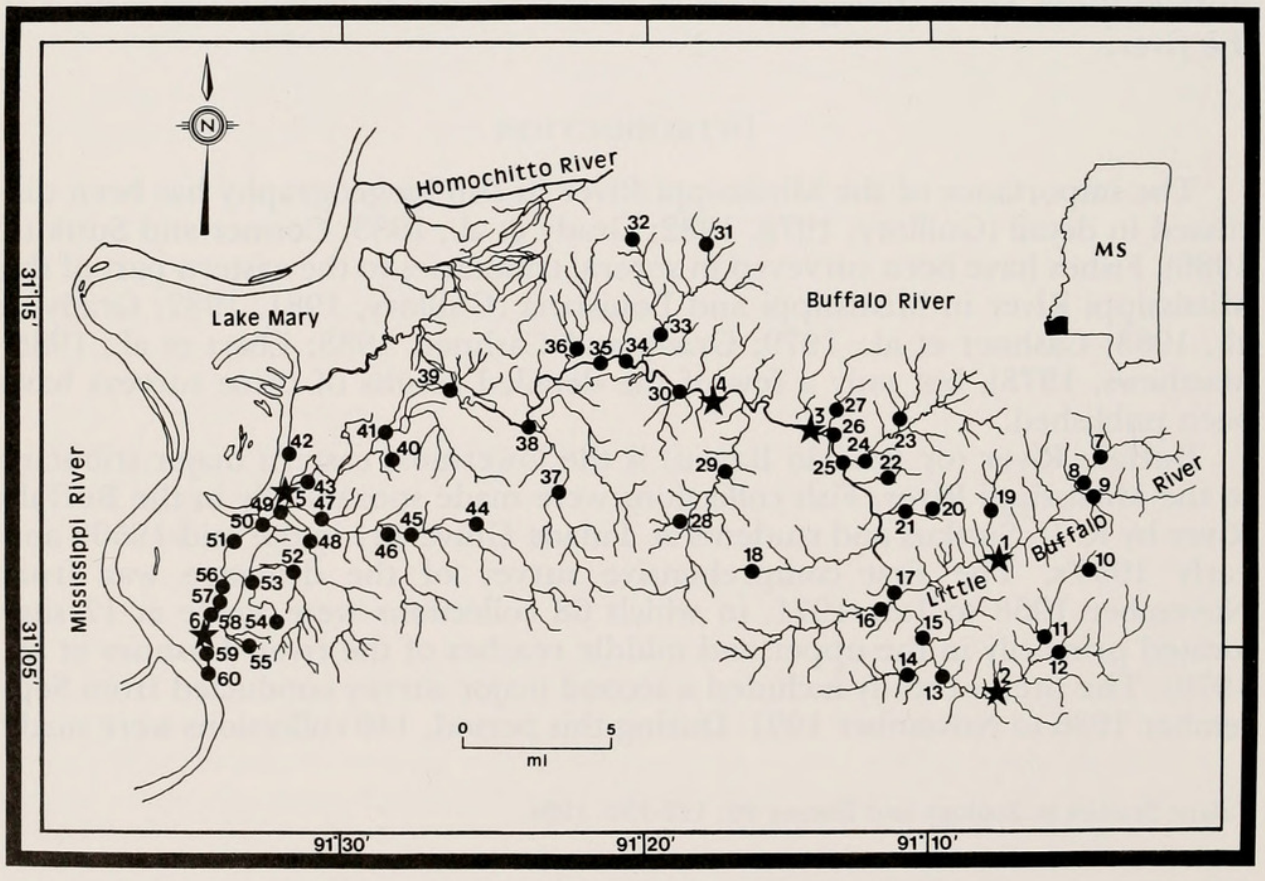

Figure 1. Map of Buffalo River, Wilkinson County, Mississippi, with collecting localities indicated.

313, approximately 1.5 miles southwest of Fort Adams, Mississippi. The elevation of the Buffalo River is 380 feet at the headwaters and 25 feet at the confluence with the Mississippi River. The average gradient is 5.6 feet/mile and the watershed area is approximately 344 square miles.

The river crosses several geological formations along its course. Headwaters are characterized by deep cut banks, a narrow channel, relatively clear water, and alternating pool, raceway, and riffle-type habitats. Here the stream exposes the alluvial sands and gravels of the Citronelle formation (Brown and Guyton, 1943; Fisk, 1951; Sibley, 1972). Sand is the dominant substrate throughout the upper headwaters, however, gravel is relatively abundant in riffle areas, and hard packed clays are found in some raceways. Farther downstream, the river traverses broad depositional Pleistocene terraces formed by Mississippi River sediments (Fisk, 1951; Sibley, 1972). The terraces, as well as the Citronelle formation to the east, are covered by loess soils (Snowden and Priddy, 1968). In this section, the river becomes larger, wider, more turbid, and mixed gravel substrates are replaced by shifting sand and mud. The lower reaches of Buffalo River cut through the recent alluvial floodplain of the Mississippi River (Fisk, 1944, 1951; Sibley, 1972). In the lower section, water levels fluctuate dramatically and are directly influenced by the Mississippi River. Slow, turbid water flowing over soft mud substrate, rich in organic detritus, is characteristic of this reach.

Terrestrial vegetation providing stream cover is abundant in the middle to upper regions of Buffalo River. A mixed coniferous-hardwood forest makes up most of the stream canopy. Aquatic vegetation is occasionally present in the upper portions of the river, with blooms of floating pond-scum (*Spirogyra* sp.) common during the spring and summer. Upland pine forest is gradually replaced by cypress-hardwood in the lower reaches of Buffalo River. Black willow (*Salix nigra*), eastern cottonwood (*Populus deltoides*) and bald cypress (*Taxodium distichum*) dominate. Aquatic vegetation is also abundant, with duck-weed (*Lemna* sp.), smart-weed (*Polygonum* sp.), duck-potato (*Sagittaria latifolia*), coon-tail (*Ceratophyllum demersum*) and American lotus (*Nelumbo lutea*) most prevalent (Caplenor et al., 1968; Fassett, 1957).

Materials and Methods

At each locality, during both surveys, a 650-1300 foot longitudinal reach of the stream was seined for approximately 1.0-1.5 hours or until all of the major macrohabitats were sampled. Collections were made using seines 10-50 feet long of 3/16 inch or 1/4 inch mesh. During the latter survey, in 1987, monofilament nylon gillnets, 150 feet × 6 feet with a 2 inch square mesh, were set at stations 5 and 6 on two different occasions (Figure 1). Monthly collections, from September 1986 to October 1987, were made at six stations established from the upper reaches of Buffalo River to near its confluence with the Mississippi River (Figure 1).

Specimens were fixed in the field with 10% formalin and stored for one week, then washed and transferred to 50% isopropyl alcohol for permanent storage. Nomenclature used in this paper follows Robins et al. (1991), except for the recognition of the families Fundulidae and Elassomatidae. All specimens collected during this study were deposited in the Vertebrate Collection at the University of New Orleans (UNOVC) or the Tulane Museum of Natural History (TU). Detailed locations of all 60 collecting sites are given in the Appendix.

Analyses of Data

Morisita's Index (I_m) and percent similarity index (PSI) were used to assess faunal similarity between stations 1-6. All species were included in the analysis following Matthews (1986a). Indices of similarity have been widely used in comparing sites within and between streams. Although the ranges of values considered by different authors to be high vary somewhat, we follow Matthews et al. (1988) in using values greater than 0.7 for PSI and I_m as indicative of relatively high degree of similarity between stations. Diversity indices (H′) were calculated (to the log base 2) for stations 1-6 (Shannon and Weaver, 1962).

Results

A total of 71,559 specimens of 74 species in 17 families was recorded from the Buffalo River drainage in the 1968-1971 survey, and in the 1986-1991 survey, 60,830 specimens of 88 species in 17 families were collected. Based on the two surveys, plus museum and literature records, the known ichthyofauna for the Buffalo River presently stands at 95 species in 20 families (Table 1).

Cyprinidae was the dominant family, both in number of species represented (26% of total) and individuals (74% of total) collected during the two surveys. The three numerically dominant species, *Cyprinella camura, Notropis longirostris,* and *Cyprinella venusta*, made up 54% of the total specimens. The cyprinids were followed by Fundulidae and Poeciliidae (5% each) and Centrarchidae (6%) in number of individuals. The Percidae, with 17%, and the Centrarchidae, with 14%, ranked second and third, respectively, behind the cyprinids in number of species represented.

During the survey of 6 permanent stations in 1986-1987, 82 collections were made yielding 79 species in 15 families (Table 2). There was an obvious change in the numerical dominance of species between the upper, middle, and lower reaches of the Buffalo River (Table 2). At stations 1 and 2, *Cyprinella camura* and *Notropis longirostris* were the most abundant and accounted for 54% of the specimens captured. At stations 3 and 4, the numerical abundance of *Cyprinella camura* and *Notropis longirostris* decreased, and *Cyprinella venusta* and *Hybognathus nuchalis* increased. These two species comprised 52% of the total specimens collected at stations 3 and 4, compared with 26% for *Cyprinella camura* and *Notropis longirostris*. In the lower portions of the river, at stations 5 and 6, *Dorosoma petenense, Gambusia affinis*, and *Lepomis macrochirus* were the most abundant forms taken.

There was virtually no similarity between the upper and middle stations 1-4, (Figure 1) and the lower ones (5 and 6, Table 3). I_m values among the upper four sites ranged from 0.34-0.94. In all but a few cases the PSI estimates were lower than I_m, as predicted by Linton et al. (1981). Only stations 1 and 2 and 3 and 4 had both I_m and PSI values suggesting relatively high faunal similarity. Based on the I_m alone, stations 1 and 2 and 1 and 3 could be regarded as highly similar to each other. Stations 5 and 6 were the only other paired stations that had I_m values near 0.70.

The most dissimilar adjacent stations were 4 and 5 ($I_m = 0.20$; PSI $= 0.17$), which had only 40% of their species in common. *Cyprinella venusta* and *Hybognathus nuchalis* accounted for 56% of the specimens taken at Station 4, but only 5% at Station 5. *Notropis texanus* (11%) and *Lythrurus fumeus* (7%) were the most common cyprinids at Station 5, and slow-water forms, such as *Gambusia affinis, Labidesthes sicculus*, and *Lepomis macrochirus*, made up nearly 50% of the catch (compared to about 7% at Station 4).

The number of species per site, for the six permanent stations, increased gradually from 30 to 37 downstream from Station 1 to Station 4, which was located near the end of the lower middle reaches of Buffalo River (Table 4). The number of species increased to 47 at Station 5 and was virtually the same at Station 6. Species diversity was highest at Station 5 ($H' = 2.56$); values at the other 5 stations varied from 2.02 to 2.15.

Seasonal Variation at Six Stations.

Similarity across seasons in the fish assemblages at the six stations was examined for species collected monthly by seines from October 1986 to September 1987. The year was divided into four seasons, autumn (September-November), winter (December-February), spring (March-May), and summer (June-August) (Table 5). Streamwide, the species richness and abundance were highest in the summer and autumn, with 61 species and 12,352 specimens, and 63 species and 8190 specimens, respectively. Fifty-eight species and 7398 specimens were taken in spring, and the winter season yielded 3188 specimens, representing 45 species.

The greatest stability in fish assemblages for the 12-month period occurred at Station 2 (Table 5). The I_m values among all seasons were high for this station (0.80 – 0.93). For Station 1, autumn-winter and winter-spring I_m values averaged 0.90, but the summer assemblage was much more variable, with I_m for spring-summer of 0.60 and 0.67 for summer-autumn. The faunal similarity at the middle sites, stations 3 and 4, was also highest between autumn, winter, and spring samples ($x = 0.75$) and lowest between the summer and the other seasons ($x = 0.48$). The lower stations, 5 and 6, were the most variable between seasons. Only autumn and winter samples at Station 5 had high similarity (0.92). The comparisons of faunal assemblages for the other seasonal pairings at these two stations ranged from 0.04 – 0.61 ($x = 0.32$). The greatest seasonal variability was at Station 6, where I_m values for the four seasons averaged just 0.25.

Longitudinal Distribution of Fishes.

Species richness in Buffalo River increases from the headwaters to the mouth. Thirty species were recorded at Station 1, and 51 by Station 4, where the river channel becomes noticeably wider and deeper (Table 4). A rather striking change in the fish fauna occurs between stations 4 and 5, where the river takes on a more distinctive lowland character. Stations 5 and 6 had the highest species number, with a total of 47 and 45 species, respectively. At these two lower stations, 28 species not collected in the upper and middle portions were added, bringing the total for the six permanent stations to 79.

Only six species appeared to be restricted to the upper reaches, and 14 others were more or less confined to the upper and middle portions, stations 1-4, of the stream course (Table 2). A group of 35 species was found primarily in the lower reaches, at stations 5 and 6, and 13 species were distributed throughout all of the six stations or were absent from only one site (Table 2).

Discussion

The general pattern of species addition has been documented in many studies for rivers and streams in the eastern and central United States (e.g., Larimore and Smith, 1963; Sheldon, 1968; Jenkins and Freeman, 1972). The Buffalo River exhibits a pattern of increased species richness downstream ac-

TABLE 1. Abundance of fish species recorded from Buffalo River, Mississippi, in 1968-1971 and 1986-1991 surveys. Asterisk indicates species based on catch by commercial fishermen or museum record.

Family and Species	Number of Specimens 1968-1971	1986-1991	Total
Petromyzontidae (lampreys)			
Ichthyomyzon gagei	15	9	24
Lampetra aepyptera	12	2	14
Polyodontidae (paddlefishes)			
*Polyodon spathula**	0	5	5
Lepisosteidae (gars)			
Lepisosteus oculatus	2	36	38
Lepisosteus osseus	0	2	2
Lepisosteus platostomus	0	3	3
Amiidae (bowfins)			
Amia calva	3	0	3
Anguillidae (freshwater eels)			
Anguilla rostrata	3	0	3
Clupeidae (herrings)			
Alosa chrysochloris	1	6	7
Dorosoma cepedianum	14	115	129
Dorosoma petenense	366	3695	4061
Cyprinidae (carps & minnows)			
*Campostoma anomalum**	0	1	1
Cyprinella camura	22427	5328	27755
Cyprinella lutrensis	25	871	896
Cyprinella venusta	11304	7846	19150
Cyprinus carpio	0	3	3
Hybognathus hayi	2	22	24
Hybognathus nuchalis	340	6781	7121
Luxilus chrysocephalus	2372	2843	5215
Lythrurus fumeus	53	1051	1104
Lythrurus umbratilis	85	330	415
Macrhybopsis storeriana	0	3	3
Nocomis leptocephalus	1569	1085	2654
Notemigonus crysoleucas	7	358	365
Notropis atherinoides	15	57	72
Notropis blennius	0	182	182
Notropis buchanani	1	0	1
Notropis longirostris	18910	5987	24897
Notropis shumardi	19	631	650
Notropis texanus	27	1715	1742
Notropis volucellus	405	280	685
Notropis winchelli	114	332	446
Opsopoeodus emiliae	55	316	371
Pimephales notatus	538	390	928
Pimephales vigilax	2061	1337	3398
Semotilus atromaculatus	57	267	324
Catostomidae (suckers)			
Carpiodes carpio	21	11	32
Erimyzon oblongus	62	20	82
Hypentelium nigricans	79	18	97
Ictiobus bubalus	9	156	165
Minytrema melanops	2	44	46
Moxostoma poecilurum	32	17	49
Ictaluridae (catfishes)			
Ameiurus melas	0	6	6
Ameiurus natalis	26	108	134
Ictalurus furcatus	1	1	2
Ictalurus punctatus	9	126	135
Noturus gyrinus	0	10	10
Noturus miurus	1585	113	1698

TABLE 1. (Continued)

Family and Species	Number of Specimens 1968-1971	1986-1991	Total
Noturus phaeus	277	84	361
Pylodictis olivaris	1	3	4
Esocidae (pikes & pickerels)			
*Esox americanus**	0	0	1
Aphredoderidae (pirate perches)			
Aphredoderus sayanus	26	94	120
Fundulidae (killifishes)			
Fundulus catenatus	2652	1145	3797
Fundulus chrysotus	0	533	533
Fundulus dispar	0	372	372
Fundulus notatus	13	171	184
Fundulus olivaceus	1457	541	1998
Poeciliidae (livebearers)			
Gambusia affinis	639	6530	7169
Atherinidae (silversides)			
Labidesthes sicculus	78	1301	1379
Menidia beryllina	46	415	461
Syngnathidae (pipefishes)			
Syngnathus scovelli	4	22	26
Percichthyidae (temperate basses)			
Morone chrysops	2	61	63
Morone mississippiensis	0	5	5
Morone saxatilis	0	7	7
Centrarchidae (sunfishes)			
Ambloplites ariommus	2	0	2
Lepomis cyanellus	107	84	191
Lepomis gulosus	25	62	87
Lepomis humilis	15	30	45
Lepomis macrochirus	461	4648	5109
Lepomis megalotis	975	508	1483
Lepomis microlophus	21	192	213
Lepomis punctatus	0	233	233
Lepomis symmetricus	0	72	72
Micropterus punctulatus	364	74	438
Micropterus salmoides	15	223	248
Pomoxis annularis	1	185	186
Pomoxis nigromaculatus	2	112	114
Elassomatidae (pygmy sunfishes)			
Elassoma zonatum	1	2	3
Percidae (perches & darters)			
Ammocrypta beani	352	48	400
Etheostoma chlorosomum	2	52	54
Etheostoma fusiforme	0	5	5
Etheostoma gracile	2	3	5
Etheostoma histrio	0	2	2
Etheostoma lynceum	495	74	569
Etheostoma parvipinne	14	3	17
Etheostoma proeliaire	10	26	36
Etheostoma stigmaeum	138	71	209
Etheostoma swaini	72	76	148
Etheostoma whipplei	87	64	151
Percina caprodes	0	1	1
Percina sciera	571	99	670
Percina shumardi	0	1	1
Percina vigil	0	50	50
Stizostedion canadense	1	0	1
Sciaenidae (drums)			
Aplodinotus grunniens	3	23	26
Total			132,396

TABLE 2. Species and number of specimens collected during the 1986-1987 survey at six permanent stations in Buffalo River, Mississippi.

	Station						
	1	2	3	4	5	6	Total
Ichthyomyzon gagei		4					4
Lampetra aepyptera	1						1
Lepisosteus oculatus					2	23	25
L. osseus					1		1
L. platostomus					1	1	2
Alosa chrysochloris						6	6
Dorosoma cepedianum					18	78	96
D. petenense					7	2750	2757
Cyprinella camura	1208	964	1094	945			4211
C. lutrensis				2	96	47	145
C. venusta	282	94	1515	2682	103	496	5172
Cyprinus carpio			2				2
Hybognathus hayi				1	4	4	9
H. nuchalis	538		843	2035	334	26	3776
Luxilus chrysocephalus	211	635	91	54			991
Lythrurus fumeus	6			14	590	58	668
L. umbratilis	12		274	8			294
Nocomis leptocephalus	144	438	5				587
Notemigonus crysoleucas		3	7		4	187	201
Notropis atherinoides					11	28	39
N. blennius						182	182
N. longirostris	1086	1364	742	807			3999
N. shumardi						631	631
N. texanus			2	156	928	189	1275
N. volucellus		1	14	232		7	254
N. winchelli	24	2	71	152			249
Opsopoeodus emiliae					256	38	294
Pimephales notatus	38	63	43	81	3		228
P. vigilax		1	145	416	117	80	759
Semotilus atromaculatus	10	2					12
Carpiodes carpio				1	1	9	11
Erimyzon oblongus	3	1	2				6
Hypentelium nigricans	3	11	2				16
Ictiobus bubalus						151	151
Minytrema melanops					41		41
Moxostoma poecilurum			2	6	6		14
Ameiurus natalis		5			1		6
Ictalurus punctatus		1	2	16	2	9	30
Noturus gyrinus				1	4		5
N. miurus	19	67					86
N. phaeus	3	67					70
Aphredoderus sayanus	1			1	26		28
Fundulus catenatus	310	363	30	17			720
F. chrysotus					429	12	441
F. dispar					273		273
F. notatus			2	3	141	15	161
F. olivaceus	107	94	50	69	2		322
Gambusia affinis	12	8	260	459	1733	2587	5059
Labidesthes sicculus				45	803	81	929
Menidia beryllina					105	184	289
Syngnathus scovelli					20	1	21
Morone chrysops						58	58
M. mississippiensis						1	1
M. saxatilis						1	1
Lepomis cyanellus	21	23	10			5	59
L. gulosus				4	18	1	23
L. humilis					24	1	25

TABLE 2. (Continued)

	Station						
	1	2	3	4	5	6	Total
L. macrochirus	21	45	32	56	1637	2505	4296
L. megalotis	80	17	35	72	126	23	353
L. microlophus					139	8	147
L. punctatus				1	222	1	224
L. symmetricus					50		50
Micropterus punctulatus	1	11	7	26	4		49
M. salmoides		1	7	1	67	125	201
Pomoxis annularis						179	179
P. nigromaculatus					6	58	64
Ammocrypta beani	2	2	9	22			35
Etheostoma chlorosomum					9	1	10
E. gracile				1		1	2
E. lynceum	19	33	1	2			55
E. parvipinne			1				1
E. proeliare					19	1	20
E. stigmaeum		2	1				3
E. swaini	6	2	4	4		5	21
E. whipplei	4	7	9	2	1		23
Percina caprodes					1		1
P. sciera	32	12	14	13			71
P. vigil	30	3	2	5			40
Aplodinotus grunniens					1	10	11
Totals	4234	4346	5328	8412	8388	10864	41572

TABLE 3. Community similarity indices for the six permanent stations for Buffalo River, Mississippi, 1986-1987. First value I_m, PSI in parentheses.

Station	1	2	3	4	5	6
1	---					
2	.89(.72)	---				
3	.77(.61)	.55(.43)	---			
4	.60(.46)	.34(.28)	.94(.79)	---		
5	.05(.08)	.02(.03)	.15(.13)	.20(.17)	---	
6	.03(.06)	.02(.04)	.15(.12)	.16(.15)	.67(.50)	---

TABLE 4. Species richness and Shannon Diversity (H′) for collections made during the 1986-1987 survey at the six permanent stations, Buffalo River, Mississippi.

Station	Species Site	Total Species for Drainage	N	H′
1	30	30	4234	2.114
2	33	38	4346	2.026
3	34	42	5328	2.077
4	37	51	8412	2.068
5	47	71	8388	2.563
6	45	79	10864	2.148

TABLE 5. Seasonal similarity (I_m) for the six permanent stations, Buffalo River, Mississippi, during 1986-1987.

Station	Aut-Win	Win-Spr	Spr-Sum	Sum-Aut	Mean
1	.91	.89	.60	.67	.77
2	.92	.80	.93	.90	.89
3	.75	.92	.43	.68	.70
4	.71	.61	.36	.44	.53
5	.92	.22	.27	.61	.51
6	.40	.37	.04	.18	.25

companied by an abrupt change in faunal components in the lowermost reaches. The major replacement of species between stations 4 and 5 is associated with the river becoming more lowland in character. A cypress swamp located at Station 5 probably acts as a natural barrier to fishes adapted to higher gradient conditions (Guillory, 1978; Matthews and Styron, 1981). Ichthyofaunal surveys conducted in drainages adjacent to the Buffalo River have shown similar patterns of species distribution (e.g., Guillory, 1982; Grady et al., 1983).

A downstream increase in species diversity occurs in most lotic systems (Hynes, 1970; Hawkes, 1975; Horwitz, 1978), and this pattern is reflected in samples at the six permanent stations on Buffalo River. Various authors have suggested that such patterns are due to an increase in available habitat or trophic diversity (Kuehne, 1962; Sheldon, 1968; Horwitz, 1978). Increasing stream size and habitat heterogeneity, along with the less variable physicochemical environment found in the lower mainstream, produces a more temporally stable environment, as compared to the headwaters, and could partially explain the high species richness and diversity values seen for stations 5 and 6 (Sheldon, 1968; Evans and Noble, 1979; Matthews and Styron, 1981; Schlosser, 1987). Some authors have suggested that characteristics of local fish assemblages are strongly related to stream order (Kuehne, 1962; Harrel et al., 1967; Whiteside and McNatt, 1972), and that stream order represents a discrete biological unit for fishes (Lotrich, 1973). We found no evidence of changes in fish assemblages correlated with changes in stream order using methods described in Matthews (1986b). The striking differences in faunal composition between stations 4 and 5 are partially enhanced by the distance between the sampling sites (21 miles) rather than just a sudden change in environmental conditions. Later collections, made between stations 4 and 5, revealed a more gradual change in the fish assemblages.

Stations 5 and 6 exhibited the greatest faunal change when compared to the other four permanent stations. Guillory (1982) concluded that transients from the faunally rich Mississippi River and adjacent floodplain were largely responsible for the high diversity at sites along Thompson Creek similar in habitat complexity to stations 5 and 6.

The diversity and species recorded for Buffalo River (95) is comparable to the richest faunas reported for tributaries to the lower eastern Mississippi River, e.g., Thompson Creek (89 species; Guillory, 1981), Bayou Sara (80 species; Grady et al., 1983), Homochitto River (105 species; Ebert et al., 1985), and Bayou Pierre (95 species; Matthews, 1978).

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APPENDIX. Locations of collection sites in Mississippi. Stations 1-6 (1-6 in Figure 1) were sampled monthly during 1986-1987, and at least one collection was made at the other 54 sites identified as 7-60 in Figure 1.

Station 1: Little Buffalo River at Macedonia Road, 2.8 miles west of Centreville, and 6.4 miles north of Highway 24 (T2N, R1E, Sec 5). **Station 2:** Buffalo River at Hiram-McGraw Road, 2.8 miles west of Centreville, 1.4 miles north of Highway 24 (T2N, R1E, Sec 34). **Station 3:** Buffalo River at Highway 563, 0.5 miles south of Wilkinson (T3N, R1W, Sec 17). **Station 4:** Buffalo River at US Highway 61, 8.5 miles north of Woodville (T3N, R2W, Sec 21). **Station 5:** Buffalo River at Highway 24, 5.1 miles west of Lessley (T2N, R4W, Sec 10). **Station 6:** Buffalo River at Jackson Point Road, 1.9 miles west of Fort Adams (T2N, R5W, Sec 18). **Station 7:** Little Buffalo River at Bluff Springs Road, 3.4 miles west of Gloster (T3N, R1E, Sec 23). **Station 8:** Little Buffalo River at Lower Gloster Road, 3.5 miles west of Gloster (T3N, R1E, Sec 26). **Station 9:** Unnamed tributary to Little Buffalo River at Mt. Carmel Road, 3.3 miles west of Gloster (T3N, R1E, Sec 26). **Station 10:** Buffalo River at Dr. Anderson Road, 3.9 miles north of Centreville (T2N, R1E, Sec 11). **Station 11:** Buffalo River at Macedonia Road, 2.3 miles northwest of Centreville (T2N, R1E, Sec 24). **Station 12:** Smith Creek

at Macedonia Road, 1.2 miles northwest of Centreville (T2N, R1E, Sec 29). **Station 13:** Buffalo River at Willie Neyland Road, 1.5 miles north of Highway 24 (T2N, R1W, Sec 25). **Station 14:** Jackson Creek at White School Road, 1.0 miles north of Highway 24 (T2N, R1W, Sec 26). **Station 15:** Buffalo River at Jones-White Road, 3.0 miles north of Highway 24 (T2N, R1W, Sec 24). **Station 16:** Browns Creek at White School Road, 3.5 miles north of Highway 24 (T2N, R1W, Sec 15). **Station 17:** Buffalo River at Little Buffalo River confluence, at White School Road, 5.0 miles north of Highway 24 (T2N, R1W, Sec 14). **Station 18:** Dry Fork Creek at Highway 563, 3.2 miles north of Woodville or 0.6 mile north of Highway 61 at Highway 563 bridge (T2N, R2W, Sec 12). **Station 19:** Dixon Creek at Henley Road, 9.0 miles north of Highway 24 (T3N, R1E, Sec 32). **Station 20:** Caledonia Creek at William Anderson Road, 6.5 miles southwest of Wilkinson (T3N, R1W, Sec 40). **Station 21:** Caledonia Creek at William Anderson Road, 5.0 miles southwest of Wilkinson (T3N, R1W, Sec 39). **Station 22:** Willis Creek at Walter Anderson Road, 5 miles southwest of Wilkinson (T3N, R1W, Sec 30). **Station 23:** Piney Creek at Highway 563, 3.0 miles northwest of Wilkinson (T3N, R1W, Sec 14). **Station 24:** Dry Creek at Walter Anderson Road, 3.0 miles southeast of Wilkinson (T3N, R1W, Sec 25). **Station 25:** Buffalo River at Dry Creek confluence, at Walter Anderson Road, 3.6 miles southeast of Wilkinson (T3N, R1W, Sec 31). **Station 26:** Buffalo River at Otis Jackson Road, 2.0 miles southeast of Wilkinson (T3N, R1W, Sec 17). **Station 27:** Silver Creek at Highway 563, 1.0 mile east of Wilkinson (T3N, R1W, Sec 16). **Station 28:** Fords Creek at Fords Creek Road, 3.6 miles north of Woodville (T2N, R2W, Sec 3). **Station 29:** Fords Creek at US Highway 61, 6.6 miles north of Woodville (T3N, R2W, Sec 41). **Station 30:** Buffalo River at Mill Creek confluence, 1.4 miles west of US Highway 61 (T3N, R2W, Sec 22). **Station 31:** Phipps Creek at Doloroso Road, 4.0 miles east of Doloroso (T4N, R2W, Sec 29). **Station 32:** Hazlit Creek at Doloroso Road, 0.7 mile east of Doloroso (T4N, R2W, Sec 26). **Station 33:** Big Piney Creek at US Highway 61, 4.0 miles southeast of Doloroso (T3N, R2W, Sec 5). **Station 34:** Buffalo River at Sanders Fork Road, 3.5 miles northeast of Lanehart (T3N, R2W, Sec 11). **Station 35:** Buffalo River 3.5 miles north of Lanehart (T3N, R2W, Sec 10). **Station 36:** Steels Creek at Woodlawn Road, 7.5 miles northeast of Lanehart (T3N, R3W, Sec 12). **Station 37:** Beaver Creek at Beaver Creek Road, 1.5 miles southwest of Lanehart (T3N, R3W, Sec 43). **Station 38:** Buffalo River at Beaver Creek confluence, 2.0 miles north of Beaver Creek Road (T3N, R3W, Sec 28). **Station 39:** Buffalo River at Southland Road, 5.0 miles north of Lessey (T3N, R3W, Sec 25). **Station 40:** Unnamed tributary to Buffalo River at Pleasant Valley Road, 3.0 miles north of Highway 24 (T3N, R4W, Sec 42). **Station 41:** Buffalo River at Pleasant Valley Road, 2.5 miles northwest of Highway 24 (T3N, R4W, Sec 27). **Station 42:** Lake Mary at Percy Creek-Sand Road, bridge at public boat ramp, 3.0 miles northwest of Highway 24 (T3N, R4W, Sec 36). **Station 43:** Unnamed cypress swamp lake, 3.7 miles north of Percy Creek-Sand Road (T2N, R4W, Sec 6). **Station 44:** Percy Creek 0.1 mile south of Highway 24 at Lessley (T2N, R3W, Sec 17). **Station 45:** Percy Creek at Bullet Branch confluence at Highway 24, 2.5 miles west of Lessley (T2N, R3W, Sec 12). **Station 46:** Hayes Creek at Highway 24, 3.0 miles west of Lessley (T2N, R4W, Sec 17). **Station 47:** Percy Creek at Percy Creek-Sand Road, 1.5 miles north of Highway 24 at Ford (T2N, R4W, Sec 6). **Station 48:** Smith Creek at Highway 24, 5.0 miles northwest of Fort Adams (T2N, R4W, Sec 20). **Station 49:** Buffalo River 0.6 mile south of Percy Creek-Sand Road bridge (T2N, R4W, Sec 10). **Station 50:** Bloomer Creek at Highway 24 bridge, 3.1 miles northeast of Fort Adams (T2N, R4W, Sec 21). **Station 51:** Belmont Lake at unmarked road, 1.3 miles northeast of Fort Adams (T2N, R4W, Sec 41). **Station 52:** Belmont Slough at unmarked road, 3.1 miles northeast of Fort Adams (T2N, R4W, Sec 27). **Station 53:** Buffalo River at confluence with Lake Mary Canal at unmarked road, 2.3 miles west of Highway 24, 4.9 miles northeast of Fort Adams (T2N, R4W, Sec 11). **Station 54:** Buffalo River at unmarked road, 1.5 miles south of confluence with Lake Mary Canal, 3.2 miles west of Highway 24 (T2N, R4W, Sec 24). **Station 55:** Unnamed tributary to Buffalo River at Pond Road, 0.7 mile east of Highway 24 (T1N, R4W, Sec 11). **Station 56:** Buffalo River, 1.5 miles north of Jackson Point Road, 1.9 miles west of Fort Adams (T2N, R4W, Sec 42). **Station 57:** Buffalo River, 1.0 miles north of Jackson Point Road, 1.9 miles west of Fort Adams (T2N, R5W, Sec 15). **Station 58:** Buffalo River, 0.5 mile north of Jackson Point Road, 1.9 miles west of Fort Adams (T2N, R5W, Sec 19). **Station 59:** Buffalo River, 0.5 mile south of Jackson Point Road, 1.9 miles west of Fort Adams (T2N, R4W, Sec 43). **Station 60:** Buffalo River at Mississippi River confluence, 1.5 miles southeast of Jackson Point Road, 1.9 miles west of Fort Adams (T1N, R4W, Sec 10).