THE PRE-IMPOUNDMENT FISH FAUNA OF BIG RIVER (MERAMEC DRAINAGE, MISSOURI)

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ABSTRACT: Eighty two species of fishes were collected from 37 localities on Big River (principal tributary of the Meramec River, East-central Missouri) from 1974-1976. Of these, 14 were newly reported from the system, and 5 others had not been collected since before 1945. The fauna is essentially "Ozarkian" and is divided into those species which are primarily headwaters and tributary inhabitants, those generally restricted to the lower river, and those widely distributed. In conjunction with literature records, we document the presence of 90 species of fishes in Big River and discuss some possible effects of the two proposed impoundments on the composition and distribution of the fauna.

Introduction. The Meramec River system of east-central Missouri lies within that portion of the state known as the Ozark uplands. It is composed of two principal tributaries in addition to the mainstream and drains all or parts of 11 counties. Big River, the larger of these two tributaries, originates in northern Iron County south of Belgrade and enters the Meramec from the south near Eureka. The headwaters of Big River drain a portion of the St. Francis Mountain region, an area composed largely of igneous rocks of Cambrian and Pre-Cambrian age. The majority of its watershed, however, lies within the Salem Plateau province where sedimentary limestones and dolomites of Ordovician age and younger predominate (Thornbury 1965: 265-268). It is a stream of approximately 235 km total length and drains a watershed of almost 1600 km^2 (Fig. 1).

The character of this stream varies from typically "Ozarkian" (i.e. clear, swift-flowing) headwaters to somewhat sluggish and more turbid conditions in the lower river. Average discharge for a 5-year period at Station 5 was 4.8 m^3/sec., increasing to 18.4 m^3/sec. (22-year average) near Station 23, to a maximum of over 22.6 m^3/sec. (49-year average) near the mouth (Fig. 1; USDI 1970). Gradient varies noticeably between the headwaters area and the lower river. The elevation of the origin is above 232 m, dropping to approximately 165 m at Station 23. Gradient then becomes more gradual with the elevation dropping to approximately 131 m at Station 35 and to approximately 124 m at confluence with the Meramec (USDI 1970). Bottom composition is primarily coarse gravel and small boulders with occasional areas of sand, mud, and limestone bedrock. Numerous small springs and spring-fed creeks enter the river in addition to five larger tributaries: Mineral Fork Creek and Mill Creek from the west; Cedar Creek and Flat River Creek from the south; and Terre Bleue Creek from the east. These tributaries are similar in character to the mainstream head-waters with the exception of Terre Bleue Creek which is similar to the lower mainstream.

The area through which Big River flows is not heavily populated and receives little pollution except as discussed below. It is basically an oak-hickory climax forest with grazing, timber, and small farms as the principal land uses. A few

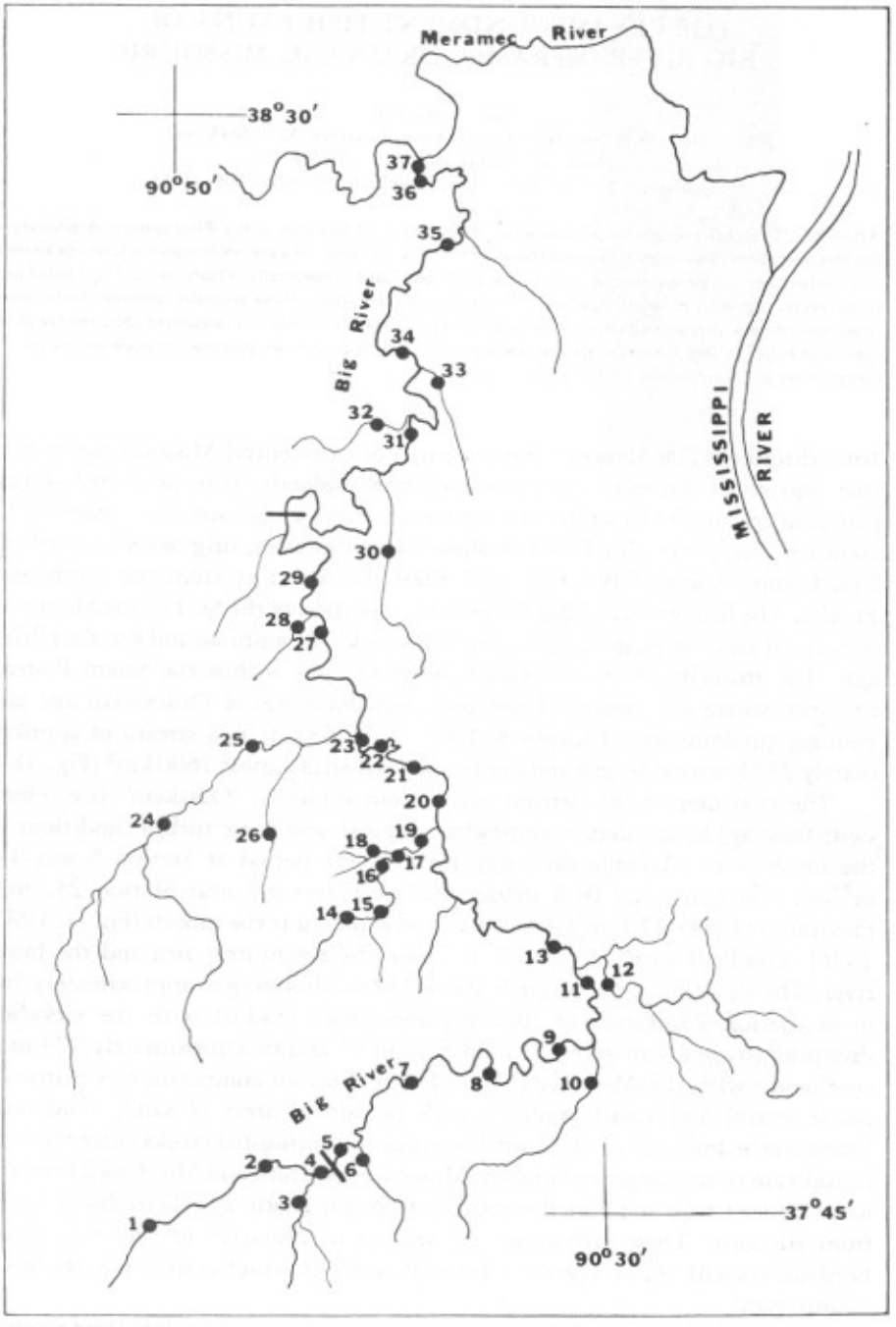

Figure 1. Map of Big River, Missouri, depicting sampling stations (1-37) and localities of two proposed impoundments (between stations 4 and 5, and stations 29 and 30).

small towns do, however, contribute some sewage effluent. Additionally, the Big River basin contains most of the tiff (barite) mines of the state as well as several inactive lead mines (Anonymous 1964). Kramer and Wixson (1977) state that water and the biota of Flat River Creek have elevated levels of zinc, lead, cadmium, and copper derived from lead mine tailings in the drainage. Large quantities of ground water pumped continously from these mines while they were in operation may have been important in maintaining water levels during periods of drought since the amount of water discharged was substantial. The barite mines are of a different character. They are strip-pit mines rather than deep-shaft and are located in an area of fine, red clay soil. Large areas of soil have been exposed to erosion through mining activities, and evidences of natural and man-treated siltation can be seen in many of the streams in the area.

The remains of five mill dams modify somewhat the lower portion of the main river by producing rather large pool areas immediately upstream. These dams are low enough to be completely inundated during floods and, therefore, do not present any significant obstacle to the movement of fishes over a long period of time.

In the summer of 1974, final approval was given by Congress to a U.S. Army Corps of Engineers flood control project which will affect the entire Meramec River system. In addition to impounding the Meramec, the project will eventually include two dams on Big River: one approximately 83 km upstream from the mouth and a second approximately 25 km downstream from the origin (Fig. 1). Funds for this project have subsequently been withdrawn, and its future is at present uncertain. There remains significant support for the project, and it has not been totally abandoned.

Although some survey work was done by the Missouri Water Pollution Board in connection with a water quality study in the early 1960's and Pflieger (1971) made representative collections of fishes within the system no comprehensive attempt has been made to document the species of fishes present in Big River nor to elucidate their distribution within the system. This survey was undertaken to provide that information prior to eventual impoundment.

Materials and Methods. Ninety collections were made from the spring of 1974 through the summer of 1976 at 37 stations, 20 of which were on the mainstream and 17 of which on tributaries (Fig. 1). Except for an occasional creel census of fishermen encountered, all specimens were collected by seining. Specimens were collected in 1.8 x 1.2m- 12.2 x 2.4m nylon mesh seines, preserved in 10% formalin, and stored in 40% isopropanol. Representatives of all species collected are housed in the Museum of Zoology, Northeast Louisiana University, Monroe; the Fish Museum of the Appalachian Environmental Laboratory, University of Maryland, Frostburg; or the Museum of Natural History of the University of Kansas, Lawrence. Nomenclature follows Bailey *et al.* (1970). Specific descriptions of all collection localities and numbers of specimens collected at each station are available from the authors upon request.

Results. A total of 76,313 specimens of 80 species was collected during the Big

River survey (Table 1). These fishes can, with some overlap, be placed in one of three groups based upon their frequency of occurrence within the system (Table 1); however, species may be occasionally encountered in areas not covered by their grouping. Categories of classification are:

1. Headwaters and tributary species: Fishes in this group are found most frequently and in greatest numbers in the smaller streams of the Big River basin. These are usually areas of very clear, cool water, relatively narrow stream width (less than 8 m), and shallow depth (50 cm or less in riffles, 1.5 m or less in pools). The bottom is usually coarse gravel and occasionally bedrock in some of the smaller tributaries. Normally there is little aquatic vegetation, but riparian vegetation is commonly associated with shorelines.

2. Lower-river species: This habitat differs considerably from the headwaters. Turbidity is higher in the lower portion of the river but averages less than 25 JTU's (Anonymous 1964; Appendix D). Width and pool depth are markedly increased (widths up to 75 m, depths to 5 m), and banks are steeper. Sand, silt, and detritus are common on the bottom although areas of clean gravel are present in the riffles and chutes. Current is reduced in the pool areas, and a smaller percentage of the total surface area is shaded by shoreline vegetation.

3. Widely distributed species: The term "widely distributed" was chosen to describe these fishes, rather than the term "ubiquitous", to avoid misleading implications as to lack of specificity of habitat requirements of any species so designated. Although all fishes in this group are likely to be encountered anywhere in the system, some species (e.g., *Hybopsis amblops*) appear to have rather specific microhabitats and are found only where these microhabitat requirements are met, whereas others (e.g., *Notropis boops*) seem truly ubiquitous.

In reference to the preceding groupings, it should be noted that our statements regarding distribution and abundance apply only to the Big River system itself and in some cases do not reflect conditions in other parts of the Meramec drainage. In cases where more than one collection was made at a particular locality, data were averaged to arrive at abundance estimates. Species marked with an asterisk (*) are placed in a particular group based upon reports of fishermen or personal observation rather than relying upon actual collections. These species were inaccessible by the collection methods employed in this survey.

Fishes listed as *Campostoma spp.* in Table 1 include both *C. anomalum* and the recently recognized *C. oligolepis* (Pflieger 1971, Burr and Smith 1976). Specific determinations were not made for all of the thousands of specimens collected, but both species were found at stations 1 and 37 and at intervening stations checked randomly. Hence, both are in the "widely distributed" group.

In addition to the 80 species of fishes collected during this survey (Table 1), literature records (Pflieger 1975) indicate eight others known from the system. These are *Ichthyomyzon castaneus, Anguilla rostrata, Hiodon tergisus, Minytrema melanops, Moxostoma anisurum, Ictalurus melas, Fundulus notatus,* and *Ammocrypta asprella*. This brings the total number of fish species now known to occur in Big River to 88.

TABLE 1. Species collected from 37 localities in Big River and its tributaries. The letters R, C, and A denote abundance: R = rare (1-5); C = common (6-50); A = abundant (more than 50). For explanation of group designations, *Campostoma* spp., and species marked (*), see text.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Headwaters and tributary species:																																					
Nocomis biguttatus	C	C	R		R			R	R						C	R	C	C	C	R	R	R		R			R	R	R	R	C	R	R	C	R	R	
Phoxinus erythrogaster	R			A		A				C				A																							
Semotilus atromaculatus	C		R	C	R	R		R		C			R	C	R	R	R		R		R	R				R	R									F
Noturus exilis	R	R	R	R	R	R				R					R				R							R		C		R	R			R	R		
Lepomis cyanellus	R					C				R	C			C	R			R	R			R															
Etheostoma flabellare	C	C	A	A	C	A		C	R	R		C	R	C	C	C			R	R		R	R	R	R	C	R	A		C	R	R	A	R	R	C	R
Etheostoma spectabile	R		C	C	R	A		R		A				A	R	R		R	R	R		R				C		R		C		C	C	R	R		R
Cottus bairdi	R	C	R												R	R																					
Lower-river species:																																					
Lepisosteus platostomus																																			R		R
Dorosoma cepedianum													C																					R	C	C	C
Alosa alabamae																																				R	R
Hybopsis aestivalis																																					R
Hybopsis storeriana																																					R
Notropis atherinoides																																					C
Notropis dorsalis																																					R
Notropis volucellus								R																			R			R				A	R	R	R
Phenacobius mirabilis																																					R
Pimephales promelas																					R									R							R
Pimephales vigilax																																		C	R	C	C
Catostomus commersoni									R																												R
Carpiodes carpio																																		R			R
Noturus nocturnus																			R															R			R
Moxostoma macrolepidotum																														R				R			
Lepomis humilis																														R				R			
Micropterus punctulatus											R									R										R							
Pomoxis annularis																														R					R	R	
Pomoxis nigromaculatus																																			R		R

TABLE 1.—cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Lower-river species cont.:																																					
Gambusia affinis	R																			C													R			R
Ammocrypta clara																																			R		C
Percina evides									R				R							R		R	C				R			C			C	R	R	R
Percina phoxocephala													R							R			R						R	R			R	R	R	R
Percina shumardi																																					R
Stizostedion canadense																																		R			
Stizostedion vitreum																																		R			
Aplodinotus grunniens																																					R
Cottus carolinae										C			R		R			R		R		R			R	R	R		R		R			C			R
Widely distributed species:																																					
*Lepisosteus osseus																															R			R	R		R
Campostoma spp.	C	A	C	A	C	A	R	A	A	C	C	C	C	A	C	R	C	C	C	A	C	A	R	C	C	C	A	C	R	C	A	C	A	A	A	A	A
*Cyprinus carpio																																				R	R
Dionda nubila	C	A	C	C	A		C	C	C		C	R	C		A	A	C	C	A	A	A	A	C	C		R	A	A		A	C	A	A	C	C		R
Ericymba buccata	R			R	R		R	C	R	R	C	R								R	C						R			R				R		C
Hybopsis amblops			R	R	R				R													C					R			R			R	R	R	R
Hybopsis x-punctata				R				R	R			R					R			R	R	R	R				C			C			R	R	C	C
Notemigonus crysoleucas					R			R				C															R			R			R	R	R	R
Pimephales notatus	R		C	C	A	R		C	C	C	C	C	C		C	A	C	R	R	A	C	C	C				C	R	C	R	A	C		A	C	C	C
Notropis boops	R		A	A	A	R	A	A	A	A	A	A	A		C	C	C	R	C	A	A	A	A				A	R		R	A		A	A	C	R	C
Notropis chrysocephalus	C	C	C	C	C	C	C	C	C	C	R	R	C		C	C	C	C	C	A	C	C	C	C			C		C	C	A	C	C	C	R	R	C
Notropis greenei		C	C	R	C			A	A		A		C		C	C	C		C	C	C	A	C		R	R	A		C		A	R		A	C		C
Notropis rubellus		R	R	R				C	R		R	R	R		C	C	C	R	C	C	C	A	A		C		R		R		C	R		C	C	C	C
Notropis spilopterus				C	C		C	C	C		C	C	C			R	R	R	R	C	C	C	C				C		R		A	C		A	A	C	A
Notropis stramineus					R		R	R	C	C	C	R	C							C	R	C	R				C				C		R	R	R	R	C
Notropis umbratilis			C	C	C		R	C		C		A	A		C					R	R	C	R				R		R		R	R	A	C	C		R
Notropis whipplei			C	C	A		A	C	C		R	C	C			R	R		R	C	A	C	C				C	R	A		A	C	R	A	A	A	A
Notropis zonatus	A	A	A	A	A	A		A	A	C	A	C	C		A	A	A	A	A	A	A	A	A	A	A	A	A	A	C	A	A	A	C	C	A	C	A
Carpiodes cyprinus																					R										R						
Carpiodes velifer					R				R																						R						

TABLE 1.—cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Widely distributed species cont.:																																					
Hypentelium nigricans	R	R	R		R		R	R	C	R	R		C		R		R	R		R	R	R	R				C		R	R	C			C	R		R
*Ictiobus bubalus									R			C																									
Moxostoma carinatum								R																							R			R			R
Moxostoma duquesnei		R			R		C	R	C	R		R	R		R					R	C	R		R		R	R	R		R			R			R
Moxostoma erythrurum					R			R	C		R	R	C							C			R			R			R	R			R	R	R	R	R
Ictalurus natalis					R					R															R	R											R
*Ictalurus punctatus	R										R												R														R
Noturus flavus								R														R				R		R		R			R		C	R
*Pylodictis olivaris																																					R
Fundulus catenatus	C	C	C	C	C	R	R	R	R	A	C	R	R		C			R	R	R	A		R	R	R	R	C		C	C	C	C	C	R		R
Fundulus olivaceus	C	R	R	R	R	R	R	R	R	A	C	R	R		R	C	C	R	R	C	R	R	R	C	R	R	C		C	C	C	C	R	R	R	R
Labidesthes sicculus	C	R	R	A	C		R	C	A	R	C	R	C			R	R		C	C	R	C	C	R		C			C	R	C	C	A	C	C
Ambloplites rupestris											R					R				R										R					C	R
Lepomis macrochirus		R	C		R	R		R		R	R	R	R	R	R					R	R	R		R		R	R		R	R	R	R	C	R	R	R	
Lepomis megalotis	R	R	A	R	C	R	C	C	C	C	C	R	C		C	C	R	R	C	C	A	C	C	R		R	C	R	C	C	C	C	R	C	C	A	C
Micropterus dolomieui	R	C		C			R	R			R	C		R	R	R	R	R	R	C	R	R		R		R	R			R	C	R	R	C	C	R	C
Micropterus salmoides		R	R		R			R			R			R		R				R						R				R		R		R	R		R
Etheostoma blennioides	C	R	C	C	R	R		C	C	R	C	C	C		C	C	C	C	C	C	R	C	C	R		R	C	C	C		C	R	C	C	R	C	C
Etheostoma caeruleum	A	A	A	A	C			A	R		C	R	C		C	C	C	C	C	R	R	C	R	C	C	C	C	C	C	A	C	R	C	C	R		R
Etheostoma nigrum			R	R				R	R	R		R	C		R	R	R	R	R	R			R				R		R		R		R		R		R
Etheostoma tetrazonum		C	R	R	R			C	R		R		R			R	R		R	R	R	C	C		C		C		C		C			C	A	C	C
Etheostoma zonale			R	C	R			C	R		R		C		R					C	C	C	C			C		C		C			C	R	C	R
Percina caprodes			R		R		R	R					R		R	R			R	R			R				R			R			R	R	R	R

Of the 80 species of fishes we collected, 17 are of special interest either because they are not previously reported from the system or because Pflieger's (1975) maps indicate a lack of recent records from Big River. The five species whose persistence in Big River was confirmed by this study are *Hybopsis amblops, Phenacobius mirabilis, Pimephales promelas, Carpiodes carpio,* and *Noturus nocturnus*. The following 12 species represent new records for Big River:

1. *Lepisosteus platostomus* Rafinesque—shortnose gar. Stations 35 and 37. Generally a fish of larger rivers in Missouri. Previously reported from one locality in the Meramec.

2. *Alosa alabamae* Jordan and Evermann—Alabama shad. Stations 36 and 37. Rare in Missouri, entering freshwater only to spawn. Known from one other locality in the Meramec.

3. *Hybopsis aestivalis* (Girard)—Speckled chub. Station 37. Common in the Missouri and Mississippi Rivers but rare elsewhere in eastern Missouri. Not previously reported from Meramec drainage.

4. *Hybopsis storeriana* (Kirtland)—Silver chub. Station 37. Generally a fish of larger rivers in Missouri. Previously reported from one station on the Bourbeuse River.

5. *Notropis atherinoides* Rafinesque—Emerald shiner. Station 37. Common in the lower portion of the Meramec.

6. *Notropis dorsalis* (Agassiz)—Bigmouth shiner. Station 37. Common north of the Missouri River, rare elsewhere. Previously reported from one station in the Meramec and one in the Bourbeuse.

7. *Ictiobus bubalus* (Rafinesque)—Smallmouth buffalo. Stations 9 and 12. Common in northern Missouri and in Mississippi River south of Missouri River influx. Known from one other location in the Meramec.

8. *Gambusia affinis* (Baird and Girard)—Mosquitofish. Stations 1, 20, 34, and 37. Formerly confined to southeast Missouri lowlands but recently expanding its range across state. Not previously reported from Meramec drainage.

9. *Micropterus punctulatus* (Rafinesque)—Spotted bass. Stations 11, 20, and 31. Formerly localized in southeast and southwest portions of the state but recently expanding its range through stocking and accidental introductions. Not previously reported from the Meramec drainage.

10. *Pomoxis nigromaculatus* (Lesueur)—Black crappie. Stations 35 and 37. Common throughout the state. Previously reported from three locations in the Meramec.

11. *Ammocrypta clara* Jordan and Meek—Western sand darter. Stations 35 and 37. Common only in southeast Missouri lowlands and in Mississippi River north of Missouri River junction. Previously reported from one location in the Meramec prior to 1945.

12. *Percina shumardi* (Girard)—River darter. Station 37. Common only in the Mississippi River and larger streams of the southeast lowlands. Previously reported from two locations in the Meramec.

Discussion. The Meramec River system drains a watershed which is quite old, having been a land area continuously since the end of the Paleozoic Era. Three subsequent uplifts (Bretz 1965) with intervening erosion cycles combined to produce the strongly dissected topography which is typical of the area today. While these erosion cycles may have resulted in some minor stream captures, there is no evidence that the drainage pattern of the upper Meramec basin has changed appreciably since the last of these uplifts in late Tertiary times. The lower portion of the Meramec basin has undoubtedly been affected by the changes in the levels of the Mississippi River associated with Pleistocene glaciation. The effect of the Mississippi River as an isolating mechanism for the Ozarks in general is discussed by Pflieger (1971). Probably the effect on the fauna of the Meramec system did not differ from that on other major drainages of the Ozark uplands.

Although the Ozarkian river systems are quite old, the fauna which now occupies and is generally distinctive of the Ozark uplands developed in the Quaternary (Pflieger 1971). This fauna is quite diverse and, in many cases, unique. Sixty-five species of fishes have their Missouri distribution centered in this area, and fourteen species are endemic (Pflieger 1975). A few years ago, the Meramec system contained the third largest number of species of any river system

in the state, with 105 species reported (Pflieger 1971). The three species new to the system reported in this study (*Hybopsis aestivalis, Gambusia affinis,* and *Micropterus punctulatus*) bring that total to 108, making it second in species richness to the St. Francis River system with 109 known species. It will be interesting to observe this system in light of the proposed impoundments and the effects which will accrue from them.

The map of the study area (Fig. 1) gives the approximate locations of the two dams proposed on Big River (between Stations 4 and 5, and 29 and 31). Since the impounded waters of the upstream dam will reach almost to Station 1, nearly all of the mainstream and the lower portions of the tributaries will be affected either by actual inundation or by changes in temperature, enrichment, sediment load, and flow regime resulting from one or both reservoirs. It is to be expected that some species will increase in abundance as a result of these changes, others will decrease, and perhaps a few will be eliminated from the system. Those species now considered as "headwaters and tributary" inhabitants will probably survive, although their ranges will decrease as suitable habitat is inundated.

Funk *et al.* (1953) documented some of the changes which occurred in Black River, a Missouri Ozark stream of somewhat similar character to Big River, after the completion of Clearwater Lake in 1948. Ruhr (1958) discussed ichthyofaunal differences in impounded and unimpounded streams in Tennessee, noting increased populations of "rough fish" after impoundment. Fitz (1968) noted similar increases of rough fish during the first years of impoundment of the Clinch River, Tennessee, by the Melion Hill dam, but game fish (bass, crappie, sunfish) numbers increased significantly as well; indigenous species not found after impoundment were chiefly those forms normally associated with rheotrophic habitats (e.g., *Hybopsis* sp., some *Notropis* sp., *Rhinichthys* sp., and *Etheostoma* sp.).

Spence and Hynes documented differences in benthos (1971a) and in fish populations (1971b) in a stream above and below Belwood Lake, Ontario. They reported differences in species composition of the benthic fauna and in four species of cyprinids which were present above but not below the impoundment. They also found (1971b) an approximate 4-week lag in the spring rise of water temperature and a maximum summer temperature 7°C lower below the lake. Erman (1973) studied the upstream portion of Sagehen Creek, California, following impoundment and found suckers to have increased from 18% to 79% of the population. Rainbow trout also increased, but brown trout and whitefish decreased and brook trout disappeared. Summers (1954) analyzed the dissolved oxygen concentration below Tenkiller Reservoir, Oklahoma, and determined that the habitat there was unsuitable for many species of fishes which required dissolved oxygen concentrations greater than 1 mg/1.

Gasaway (1970) summarized the first 16 years of fisheries data from Lake Francis Case, South Dakota, following impoundment. The total number of adult fish declined by the end of the study, with only goldeye, channel catfish, northern redhorse, emerald shiner, white bass, walleye, and flathead catfish populations remaining either stable or increasing.

It seems likely that similar changes in faunal composition can be expected in Big River. Darters and riffle-dwelling minnows now make up a large part of the fauna, with smallmouth bass *(Micropterus dolomieui)* and rock bass *(Ambloplites rupestris)* constituting a major portion of the game fish population. As riffle areas are reduced and the character of pool areas changes, these are likely to be supplanted by more pelagic forms. Game fish populations will probably shift in favor of a bluegill-largemouth bass-crappie composition, riffle-dwellers will yield dominance to pelagic minnows, and there will be an increase in such species as gizzard shad, carp, buffalo, and drum.

It is difficult to predict which, if any, species may suffer post-impoundment extirpation from the system. However, *Noturus nocturnus* and *Ammocrypta clara*, among others, will require observation due to their apparent localization and specificity of habitat requirements.

Acknowledgements. The authors wish to recognize Drs. Frank B. Cross and Neil H. Douglas who reviewed various stages of the manuscript and offered critical comment. This research was supported in part by Dresser Industries, Inc., Houston, Texas.

Addendum. After this manuscript was completed, Mills collected two adult specimens of *Lepomis gulosus* and one juvenile specimen of *L. microlophus* from station 3 on 11 Aug. 1977. Neither of these was previously reported from Big River. This brings to 90 the number of species of fishes now known from this system.

LITERATURE CITED

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