

EFFECTS OF IMPOUNDMENT ON THE FISHES IN TWO KENTUCKY TAILWATERS

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Abstract: The most noticeable differences in the pre- and post-impoundment tailwater fish communities in Green and Barren rivers, Kentucky, were reduced biomass, loss of cyprinid species, increased game-fish numbers, and decreased rough-fish numbers. These differences were attributed to altered post-impoundment environmental conditions in the tailwater (lowered water temperatures and irregular flow patterns), and species recruitment through the dams. Carp, while not present before impoundment in the tailwater reaches, represented a prominent component of the community after damming.

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Studies describing the effects of impoundments on tailwater fishes have most often been directed toward coldwater environments (hypolimnion releases) (Pfitzer 1962, Carter 1969, Spence and Hynes 1971, Edwards 1978). Some of these studies were conducted within 1-5 years following impoundment (Pfitzer 1962, Carter 1969), while others were carried out many years after impoundment and compared the ichthyofauna in the tailwater with that in the river above the lake (Spence and Hynes 1971). The objectives of this study were to describe the tailwater fish communities in the Green and Barren rivers, Kentucky, 10 and 13 years, respectively, following impoundment; compare the existing ichthyofauna with that from the same stream reaches before and immediately after impoundment (Carter 1966, 1969, Turner 1959); and describe any identifiable effects impoundment has had upon the tailwater fishery.

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MATERIALS

The tailwaters selected for study originated from 2 U.S. Army Corps of Engineer lakes in south-central Kentucky. Green River Lake (3,300 surface ha) and its tailwater are located in Taylor and Green counties, and Barren River Lake (4,000 surface ha) and tailwater in Allen and Barren counties, Kentucky. The Green River tailwater section studied extended from the dam (River Kilometer 491) approximately 23 km downstream. The Barren River tailwater section studied extended from the dam (River Kilometer 127) downstream to the Highway 101 bridge, approximately 21 km. Five sampling stations on each tailwater were selected on the basis of available habitat, physiographic features such as riffle-pool configuration (overall average of approximately 50% riffle-pool), and accessibility to electroshocking. Sampling stations on the Green River averaged 0.2 surface ha and ranged from 0.06 ha to 0.31 ha. Barren River stations were smaller averaging 0.1 ha with a range of 0.06 ha to 0.14 ha.

Fishes of both tailwaters were sampled in the fall of 1978, and the spring and summer of 1979. All collections were made at approximate minimum lake discharges which were

controlled and made available upon request by the Louisville District Office of the U.S. Army Corps of Engineers. Minimum flows were instituted 12 hours before the first station was sampled. Minimum flows experienced while sampling were 2.4 m³/sec on the Green River, and 2.1 m³/sec on the Barren. For the 1978-79 water year (October 1978 - September 1979), Green River flows averaged 58.8 m³/sec with extremes of 0.54 and 215 m³/sec. Barren River flows for the same period averaged 78.3 m³/sec with a range of 2.1 to 202 m³/sec. Flow conditions in the Barren River in 1962-63, 1 year before impoundment, was considerably lower averaging 42 m³/sec for the year, but had a higher maximum flow period of 253 m³/sec.

Fish were sampled by electroseining, electrofishing with long-handle probes, and rotenone application. The electroseine used was a "Kentucky seine" as described in Carlander (1957). The seine was 15 m long and charged by a 2,560 watt alternator at 230 volts. The electroseine was used in the fall 1978 collections, but its use in the remaining seasons was precluded by a malfunction in the control box. The remaining collections were made with 2 pairs of hand held probes powered by the above described alternator.

Prior to sampling, block seines of 5 mm mesh were placed above and below each station. Sampling included shocking downstream through the station, covering all reaches, to the lower block seine, reversing, and moving back upstream to the upper block net. All samples were taken during daylight. Representatives of harvestable size sport fish were measured, weighed, and released alive. All other fish were retained and fixed in 10 percent formalin. Total lengths, weights, and identifications were recorded for all fish taken in the study.

Physico-chemical features including temperature, dissolved oxygen, pH, total alkalinity, and total hardness were recorded at the most upstream and downstream station on each tailwater for each of the 3 seasons of the study. Rotenone samples were made in conjunction with biologists of the Kentucky Department of Fish and Wildlife Resources. The most downstream station on each tailwater was sampled with rotenone in the fall of 1978 and summer of 1979, after the station had been sampled by electroshocking.

Fishes were categorized as sport species (trout, crappie, blackbasses, and sunfishes), rough species (gar, suckers, carp, and catfishes), and forage species (shad, minnows, madtoms, darters, and sculpins) after Lagler (1956), except that food fish, namely catfish, were included as rough species.

RESULTS

Green River Tailwater

The species composition of the fish community in the Green River tailwater in 1978-79 differed in several respects from that prior to impoundment. In a 1960-62 pre-impoundment study, 7-9 years before impoundment, 57 species were collected in the future tailwater reach (Stations -21.5 and -34.7, Charles 1964), while 46 species were taken in 1978-79, 13 years after impoundment (Table I). Thirty-two species were common to both studies. Of the 25 species not observed in the post-impoundment study, 7 were cyprinids, 6 were ictalurid species, and 8 have been collected by other workers (East Central Reservoir Investigations, personal communication). Six species of darters were taken in 1978-79 that were absent in the earlier study.

Higher standing crops were observed prior to lake filling, 64 kg/ha, Kentucky Department of Fish and Wildlife Resources, personal communication, than in 1978-79, 33 kg/ha. This difference in weight was also reflected in the number of fish per hectare in the 2 studies, 1,996 fish per ha in 1962 and 834 in 1978-79. Seasonally, the greatest average post-impoundment standing crop estimate, 37 kg/ha, was observed in the spring and the lowest, 19 kg/ha, in the summer. No seasonal pre-impoundment data were available.

Data taken at the downstream station in the fall and summer with rotenone and electroshocking showed markedly different standing crops. In the fall, rotenone identified

Table 1. Fishes taken from the Green River Lake tailwater before impoundment, 1960-62, and after impoundment, 1978-79.

Species taken only in 1960-62	Species taken in 1960-62 and 1978-79	Species taken only in 1978-79
<i>Esox americanus</i>	<i>Lepisosteus osseus</i>	<i>Ichthyomyzon bdellium</i>
<i>Nocomis biguttata</i>	<i>Dorosoma cepedianum</i>	<i>Salmo gairdneri</i>
<i>Nocomis micropogon</i>	<i>Campostoma anomalum</i>	<i>Cyprinus carpio</i>
<i>Notropis atherinoides</i>	<i>Hybopsis amblops</i>	<i>Notropis ardens</i>
<i>Notropis volucellus</i>	<i>Hybopsis dissimilis</i>	<i>Notropis photogenis</i>
<i>Phenacobius uranops</i>	<i>Notropis ariommus</i>	<i>Phenacobius mirabilis</i>
<i>Pimephales vigilax</i>	<i>Notropis cornutus</i>	<i>Noturus elegans</i>
<i>Semotilus atromaculatus</i>	<i>Notropis rubellus</i>	<i>Morone chrysops</i>
<i>Minytrema melanops</i> ¹	<i>Notropis spilopterus</i>	<i>Etheostoma bellum</i>
<i>Moxostoma carinatum</i> ¹	<i>Pimephales notatus</i>	<i>Etheostoma flabellare</i>
<i>Ictalurus natalis</i>	<i>Hypentelium nigricans</i>	<i>Etheostoma maculatum</i>
<i>Noturus exilis</i>	<i>Moxostoma duquesnei</i>	<i>Etheostoma zonale</i>
<i>Noturus furiosus</i>	<i>Moxostoma erythrurum</i>	<i>Percina copelandi</i>
<i>Noturus nocturnus</i>	<i>Moxostoma macrolepidotum</i>	<i>Percina evides</i>
<i>Noturus sp.</i>	<i>Ictalurus punctatus</i>	
<i>Pylodictis olivaris</i> ¹	<i>Labidesthes sicculus</i>	
<i>Fundulus catenatus</i> ¹	<i>Lepomis macrochirus</i>	
<i>Lepomis cyanellus</i> ¹	<i>Lepomis megalotis</i>	
<i>Lepomis gulosus</i> ¹	<i>Micropterus dolomieu</i>	
<i>Pomoxis nigromaculatus</i>	<i>Micropterus punctulatus</i>	
<i>Etheostoma camurum</i>	<i>Micropterus salmoides</i>	
<i>Percina cymatotaenia</i>	<i>Pomoxis annularis</i>	
<i>Stizostedion canadense</i> ¹	<i>Etheostoma blennioides</i>	
<i>Stizostedion vitreum</i> ¹	<i>Etheostoma caeruleum</i>	
	<i>Etheostoma kennicotti</i>	
	<i>Etheostoma stigmaeum</i>	
	<i>Percina caprodes</i>	
	<i>Percina macrocephala</i>	
	<i>Percina phoxocephala</i>	
	<i>Percina sciera</i>	
	<i>Cottus caroliniae</i>	

¹denotes species known to still occur in the tailwater.

115 kg of fish per ha immediately after electroshocking took 44 kg/ha. Likewise, in the summer, electrofishing took 10 kg/ha while rotenone took 20 kg/ha.

Forage species made up the majority of individuals in both studies with 65 and 66 percent, while rough species decreased in relative abundance from 22 percent of the total before impoundment to 8 percent after. Sport fish numbers increased from 12 percent before impoundment to 27 percent after, due primarily to increases in white crappie and rainbow trout. These density changes by rough and sport species were not evidenced in biomass make-up, however, as the weight composition of the 3 fish categories was similar for the 2 studies (Table 2). Rough species dominated in biomass in both studies.

Table 2. Percent composition and number and weight per hectare of rough, forage, and sport fish species in Green and Barren River tailwaters before and after impoundment, electroshocking and rotenone data combined.

GREEN RIVER TAILWATER						
Biomass	Rough Species		Forage Species		Sport Species	
	Wt	Percent	Wt	Percent	Wt	Percent
Pre-impoundment						
1960-62	35.9	56	6.9	11	21.6	33
Post-impoundment						
1978-79	19.6	59	3.0	9	10.6	32

Number	No.	Percent	No.	Percent	No.	Percent
Pre-impoundment						
1960-62	441	22	1,311	66	244	12
Post-impoundment						
1978-79	67	8	542	65	225	27
BARREN RIVER TAILWATER						
Biomass	Rough Species		Forage Species		Sport Species	
	Wt	Percent	Wt	Percent	Wt	Percent
Pre-impoundment						
1958-64	173.0	93	6.6	4	5.6	3
Post-impoundment						
1978-79	33.0	75	5.7	13	5.3	12

Number	No.	Percent	No.	Percent	No.	Percent
Pre-impoundment						
1958-64	759	42	921	51	126	7
Post-impoundment						
1978-79	58	13	196	44	192	43

Following impoundment, darters, northern hog sucker, and white crappie increased in abundance while cyprinids, spotted sucker, redhorses, channel catfish, madtoms, rock bass, spotted bass, and smallmouth bass decreased (Table 3). Rainbow trout and carp were collected in tailwater reaches only in post-impoundment samples. Numerically, the most abundant species in the tailwater was the bluntnose minnow with 36 percent of the total before impoundment and 23 percent after.

The composition of the 1978-79 post-impoundment community changed seasonally. In the fall, forage species dominated representing 82 percent of the total while sport species

Table 3. Number and weight of fishes collected in the Green River tailwater before and after impoundment. Pre-impoundment data are from the Kentucky Department of Fish and Wildlife Resources, personal communication.

Species	Pre-Impoundment 1960 - 1962		Post-Impoundment 1978 - 1979	
	No.	Wt.(Kg)	No.	Wt.(Kg)
Gizzard shad	6	5.0	57	3.3
Rainbow trout	0	0.0	40	5.4
Cyprinids	2,071	6.5	864	3.6
Carp	0	0.0	18	14.2
Northern hog sucker	41	2.9	65	8.0
Spotted sucker	60	2.4	0	0.0
Redhorses	662	48.2	92	28.4
Channel catfish	13	7.0	1	tr
Madtoms	163	tr	14	tr
Rock bass	82	11.0	35	4.4
Longear sunfish	179	4.8	92	3.2
Spotted bass	67	6.5	15	1.9
Smallmouth bass	58	11.9	2	tr
White crappie	7	0.5	362	12.8
Darters	86	tr	509	1.2
Miscellaneous (gar, sculpin, etc.)	198	12.1	103	3.5
TOTAL	3,693	119.3	2,269	90.2

(67%) were most abundant in the spring (Table 4). By late summer, forage species were again most numerous making up 67 percent of the total. Biomass was dominated in all seasons by rough species, 69 percent in the fall, 61 percent in spring, and 48 percent in summer. Sport species also represented a considerable component of total weight with 46 percent in the spring and 29 percent in the summer. No seasonal information was available for the pre-impoundment study.

Barren River Tailwater

The species composition of the fish community in the future tailwater changed noticeably from pre-impoundment conditions, 1958-65, to post-impoundment, 1965 to 1978-79. In the tailwater area, 7 cyprinid and 3 darter species observed prior to impoundment were not collected in 1965, 1 year following impoundment (Table 5; Kentucky Department of Fish and Wildlife Resources, personal communication), or 1979, 15 years later (Table 6). New tailwater species observed 1 year after impoundment were species characteristic of streams below lakes. They included threadfin shad, mooneye, bullheads, white bass, carp, smallmouth and largemouth bass, white crappie, brook silverside, and walleye (Table 5). From 1965 to 1979, changes observed were the addition of 4 minnow species, 4 darters, and rainbow trout (Table 6). Of 17 species observed in 1965 but not in 1978-79, 8 were collected by other workers (East Central Reservoir Investigations, personal communication) (Table 6), and, with the exception of the threadfin shad, all the others are likely present-day inhabitants. Seventeen species observed in 1978-79 were likewise present in 1958, before impoundment.

Table 4. Percent composition and number and weight per hectare of individuals of rough, forage, and sport fish species by season in Green and Barren River tailwaters, 1978-79, electroshocking and rotenone data combined.

GREEN RIVER TAILWATER						
Biomass	Fall		Spring		Summer	
	Wt	Percent	Wt	Percent	Wt	Percent
Rough Species	22.0	69	17.8	48	11.6	61
Forage Species	4.2	13	2.2	6	1.9	10
Sport Species	5.8	18	17.0	46	5.5	29

Number	No.	Percent	No.	Percent	No.	Percent
Rough Species	27	7	10	9	7	9
Forage Species	322	82	25	24	50	67
Sport Species	43	11	71	67	18	24
BARREN RIVER TAILWATER						
Biomass	Fall		Spring		Summer	
	Wt	Percent	Wt	Percent	Wt	Percent
Rough Species	29.2	72	53.5	81	18.4	67
Forage Species	4.4	11	4.5	7	2.2	8
Sport Species	6.9	17	8.0	12	6.8	25

Number	No.	Percent	No.	Percent	No.	Percent
Rough Species	13	14	6	13	5	9
Forage Species	57	62	12	26	31	55
Sport Species	22	24	28	61	21	36

Standing crop estimates were significantly higher before impoundment, 186 kg/ha Kentucky Department of Fish and Wildlife Resources, personal communication) than in 1978-79, 44 kg/ha. The number of fish observed was likewise proportionally greater in the pre-impoundment study, 1806 fish/ha than in 1978-79, 446 fish/ha. Seasonally, the greatest average standing crop observed in the 1978-79 study was 66 kg/ha in the spring and the lowest, 27 kg/ha, was observed in the summer. No seasonal standing crop data were available for the earlier studies.

Electrofishing versus rotenone samples at the downstream station were similar in trend to those in the Green River, 74 kg/ha by rotenone immediately after electroshocking took 30 kg/ha.

Rough species represented the major biomass component in the Barren tailwater in all 3 studies while forage and sport species were the most abundant (Table 2). Rough species decreased in numbers and weight since impoundment while sport species have shown the opposite trend, increasing in number and weight. Forage species decreased in number but increased in weight since impoundment. Also evident from the studies was an immediate,

Table 5. Fishes taken from the Barren River Lake tailwater before impoundment, 1958-64, and immediately after impoundment, 1965-66.

Species taken only in 1958-64	Species taken in 1958-64 and 1965-66	Species taken only in 1965-66
<i>Campostoma anomalum</i>	<i>Lepisosteus osseus</i>	<i>Dorosoma petenense</i>
<i>Hybopsis aestivalis</i>	<i>Dorosoma cepedianum</i>	<i>Carassius auratus</i>
<i>Hybopsis amblops</i>	<i>Hybopsis dissimilis</i>	<i>Cyprinus carpio</i>
<i>Notropis ardens</i>	<i>Notropis atherinoides</i>	<i>Ictalurus melas</i>
<i>Notropis boops</i>	<i>Notropis cornutus</i>	<i>Ictalurus natalis</i>
<i>Notropis volucellus</i>	<i>Notropis photogenis</i>	<i>Labidesthes sicculus</i>
<i>Notropis whipplei</i>	<i>Notropis spilopterus</i>	<i>Lepomis cyanellus</i>
<i>Pimephales vigilax</i>	<i>Pimephales notatus</i>	<i>Lepomis gulosus</i>
<i>Noturus nocturnus</i>	<i>Hypentelium nigricans</i>	<i>Micropterus dolomieu</i>
<i>Noturus sp.</i>	<i>Minytrema melanops</i>	<i>Micropterus salmoides</i>
<i>Etheostoma stigmaeum</i>	<i>Moxostoma anisurum</i>	<i>Pomoxis annularis</i>
<i>Percina macrocephala</i>	<i>Moxostoma macrolepidotum</i>	<i>Morone chrysops</i>
<i>Percina maculata</i>	<i>Moxostoma erythrurum</i>	<i>Stizostedion vitreum</i>
<i>Percina sciera</i>	<i>Ictalurus punctatus</i>	
	<i>Pylodictis olivaris</i>	
	<i>Noturus miurus</i>	
	<i>Ambloplites rupestris</i>	
	<i>Lepomis macrochirus</i>	
	<i>Lepomis megalotis</i>	
	<i>Micropterus punctulatus</i>	
	<i>Pomoxis nigromaculatus</i>	
	<i>Percina phoxocephala</i>	
	<i>Aplodinotus grunniens</i>	
	<i>Cottus carolinae</i>	

short term reorganization of the tailwater ichthyofauna following impoundment. Rough fish biomass dropped while that of sport fish increased, and forage number decreased during the first year. These fluctuations had partially recovered by 1978-79 (Table 2).

Immediately following impoundment, species characteristic of lakes, i.e., threadfin shad, carp, bluegill, spotted bass, largemouth bass, and crappie species showed great increases in the Barren tailwater (Table 7). Likewise, noticeable decreases in certain species were observed including cyprinids, channel catfish, flathead catfish, madtoms, and drum. Thirteen years later, these initial marked changes in abundance had moderated with the long-term effects of impoundment including slight increases in gizzard shad, carp, northern hog sucker, bluegill, longear sunfish, white crappie, and darters, and decreases in cyprinids, catfishes, redborses, and drum. Carp and rainbow trout were observed following impoundment only.

In the 1978-79 study, forage species were most abundant in the fall and summer, making up 62 and 55 percent of the total number, respectively, while sport fish were prevalent, 61

Table 6. Fishes taken from the Barren River Lake tailwater following impoundment in 1965-66 and 1978-79.

Species taken only in 1965-66	Species taken in 1965-66 and 1978-79	Species taken only in 1978-79
<i>Lepisosteus osseus</i> ¹	<i>Dorosoma cepedianum</i>	<i>Salmo gairdneri</i>
<i>Dorosoma petenense</i>	<i>Cyprinus carpio</i>	<i>Campostoma anomalum</i>
<i>Carassius auratus</i>	<i>Hybopsis dissimilis</i>	<i>Notropis rubellus</i>
<i>Notropis photogenis</i>	<i>Notropis cornutus</i>	<i>Notropis leuciodus</i>
<i>Notropis atherinoides</i> ¹	<i>Notropis spilopterus</i>	<i>Notropis stramineus</i>
<i>Moxostoma anisurum</i>	<i>Pimephales notatus</i>	<i>Phenacobius mirabilis</i>
<i>Moxostoma macrolepidotum</i> ¹	<i>Hypentelium nigricans</i>	<i>Etheostoma caeruleum</i>
<i>Ictalurus melas</i>	<i>Minytrema melanops</i>	<i>Etheostoma zonale</i>
<i>Ictalurus natalis</i>	<i>Moxostoma erythrurum</i>	<i>Percina sciera</i>
<i>Noturus miurus</i>	<i>Ictalurus punctatus</i>	<i>Percina caprodes</i>
<i>Morone chrysops</i> ¹	<i>Pylodictis olivaris</i>	<i>Anguilla rostrata</i>
<i>Lepomis gulosus</i> ¹	<i>Ambloplites rupestris</i>	
<i>Micropterus dolomieu</i> ¹	<i>Lepomis cyanellus</i>	
<i>Micropterus salmoides</i> ¹	<i>Lepomis macrochirus</i>	
<i>Pomoxis nigromaculatus</i> ¹	<i>Lepomis megalotis</i>	
<i>Stizostedion vitreum</i> ¹	<i>Micropterus punctulatus</i>	
<i>Aplodinotus grunniens</i> ¹	<i>Pomoxis annularis</i>	
	<i>Percina phoxocephala</i>	
	<i>Cottus carolinae</i>	
	<i>Labidesthes sicculus</i>	

¹denotes species known to still occur in the tailwater.

percent in the spring. While sport fish numbers increased in the spring, their corresponding weight decreased. This increase in number resulted from increases in white crappie, bluegill, and most notably, small longear sunfish. The decrease in forage species was concurrent with reduced numbers of stonerollers and spotfin shiners. Rough fish, while including relatively few individuals, represented the major biomass component seasonally ranging from 81 percent in the spring to 67 percent in the summer. In 1965-66, immediately following impoundment, forage species were also most abundant in the fall, but rough species were most abundant in the spring and sport species in the summer. Rough species again represented the greatest weight component.

DISCUSSION

The tailwater fishes of the Green and Barren Rivers responded similarly to impoundment 10 and 13 years after damming. The most noticeable changes observed of reduced standing crops, loss of minnow species, decreased rough fish numbers, and increased sport fish numbers after impoundment have been reported in post-impoundment studies by Pfitzer (1962), Carter (1966), Spence and Hynes (1971), and Edwards (1978).

Marked differences observed between pre- and post-impoundment standing crop estimates were attributable to the use of rotenone as a sampling agent prior to damming while

Table 7. Number and weight in kg of fishes collected in the Barren River tailwater before and after impoundment. Pre-impoundment data are from the Kentucky Department of Fish and Wildlife Resources, personal communication.

	Pre-Impoundment		Post-Impoundment		Post-Impoundment	
	1958 - 1964		1965 - 1966		1978 - 1979	
	No.	Wt	No.	Wt	No.	Wt
Gizzard shad	5	1.5	390	24.7	62	3.5
Threadfin shad	0	0.0	243	2.0	0	0.0
Rainbow trout	0	0.0	0	0.0	12	1.6
Cyprinids	334	0.9	18	tr	204	1.7
Carp	0	0.0	398	120.9	40	39.8
Channel catfish	92	17.9	4	2.4	5	tr
Bullheads	0	0.0	281	9.5	0	0.0
Flathead catfish	71	13.8	6	5.6	10	3.0
Madtoms	20	tr	0	0.0	0	0.0
Northern hog sucker	1	tr	8	1.9	24	4.3
Spotted sucker	7	1.2	110	12.0	1	tr
Redhorses	112	19.0	239	59.9	3	1.9
Bluegill	3	tr	140	4.9	39	1.5
Longear sunfish	14	tr	183	4.7	165	4.6
Spotted bass	30	1.4	87	21.8	28	1.7
Largemouth bass	0	0.0	41	12.8	0	0.0
White Crappie	0	0.0	73	3.9	13	tr
Black Crappie	2	tr	638	18.8	0	0.0
Darters	9	tr	6	tr	59	tr
Freshwater drum	22	13.8	2	4.7	0	0.0
Miscellaneous (gar, sculpin, etc.)	9	4.3	48	9.3	44	3.9
TOTAL	731	75.0	2,915	320.0	709	70.0

electrofishing methods were mainly used after, and the larger areas sampled before impoundment (0.67 ha average) than after (0.14 ha). The rotenone-electroshocking data observed in this study supported this contention.

Pfizer (1962), Spence and Hynes (1971), and Carter (1966) all reported the loss of tailwater minnow species following impoundment. Pfizer (1962) suggested a reduced forage tendency on the part of the post-impoundment ichthyofauna. Initial minnow losses in the Green River were accompanied through time by the addition of new darter species as replacement forage forms. In the Barren River, lost cyprinid species were replaced by other cyprinids 13 years later.

The impact of dams upon downstream fishes described by Edwards (1978), Pfizer (1962), and Spence and Hynes (1971) resulted from the release of cold, hypolimnion water into receiving streams. The 2 tailwaters investigated in this study represented typical coldwater tailwaters with average annual temperatures of 13.7 C (4.0°-22.4° C) in the Green River and 14.5° C (5.9°-24.4° C) in the Barren River. However, in the Green and Barren Rivers, species observations were made that identified impoundment influences

other than temperature on tailwater fishes. For example, Spence and Hynes (1971) reported the bluntnose minnow to be 1 of 4 cyprinid species absent from the tailwaters of a hypolimnal release lake and suggested it's absence to be temperature dependent. In the Green River, the bluntnose minnow constituted 36 percent of the total before impoundment and 23 percent after, temperature not critically affecting the species in this particular situation. In identifying common ecological requirements of those species present before but absent following impoundment, the 2 most commonly shared sets of features of those species were, spring fed, high gradient, smaller streams having well oxygenated swift riffles (creek chub, madtom species, stoneroller, rosefin shiner, speckled darter, bluebreast darter, longhead darter, and blackside darter), and moderate to low gradient stream reaches having sluggish pools, gentle flow and no turbulence (grass pickerel, speckled and bigeye chubs, mimic shiner, stargazing minnow, and bullhead minnow) (Clay 1975). Based upon this information, it was felt that, in addition to temperature, the irregular flow patterns of the 2 tailwaters produced a different set of flow conditions that altered habitat selection and maintenance by certain species.

It has become generally accepted that tailwater fisheries are influenced in large measure by lake fishes which pass through dams. The increased abundance of sport fish in the tailwaters in this study was attributed to this feature. Carter (1966) reported sport fishes in the Barren River tailwater to be dominated by species characteristic of the lake. Pfitzer (1962) reported similar conclusions in Tennessee. The decrease in rough fish numbers occurred as catfish and redhorse species failed to adjust to the altered post-impoundment environmental conditions, lowered temperature and irregular flow patterns, and moved further downstream.

Carp made up a sizeable percentage of rough fish number and weight in both tailwaters. The species was not observed in the tailwater reaches of either tailwater in the pre-impoundment studies. Pfitzer (1962) likewise failed to observe carp in pre-impoundment studies in Tennessee, but reported it after. This feature suggested a portal of entry into the tailwater by way of the reservoir, probably a result of the inundation of farm ponds containing the species as the lake filled. The carp has been described by Clay (1975) as a warmwater species, preferring standing water to sluggish streams. This species success in establishing in the 2 tailwaters in this study amplified its capacity to succeed in a broad set of environmental conditions.

Qualitative differences observed in the tailwater fish populations of the Green and Barren rivers were attributed to stream bed physiography and habitat differences. The Green River had shallow banks with a few midstream obstructions, long shallow pools with narrow troughs along 1 bank, and large rocks as the most common habitat type. The Barren River included short, deeper pools, diverse bank habitat (logs, brush, undercut, steep banks), and midstream debris of large, fallen trees and stumps throughout the tailwater.

Seasonal biomass trends, highest in spring and lowest in summer were also reported by Carter (1968). Spring biomass increases in the Green River resulted from marked increases in numbers and size of golden redhorse, black redhorse, and white crappie which were probably related to reproductive activity. The similar biomass increase in Barren River resulted from increased numbers of carp, also probably related to reproduction.

The number of species observed in this study was generally similar to that in the literature for both tailwaters. Turner (1959) in a pre-impoundment study and Carter (1966) in a post-impoundment study on the Barren River, reported 38 and 32 species, respectively, from the tailwater area. Thirty-one species were observed in this study. Charles (1964) reported 57 species from the future tailwater area of the Green River in a pre-impoundment study. Forty-six species were taken in the present study.

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