

The Fish Communities of Big Vermillion River and Sugar Creek

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Introduction

The waters of Big Vermillion River and Sugar Creek enter the Wabash River 20 kilometers apart in Vermillion and Parke County, Indiana respectively. In 1979 and 1980 sampling programs of their fish communities were undertaken as part of a long-term study of the middle Wabash River. We wished to (1) determine the nature of the fish communities in the lower portions of each tributary and (2) assess their potential relationship to the Wabash River and its fish community.

The Study Streams

Big Vermillion River and Sugar Creek both flow through wooded valleys on their way to the Wabash River. Big Vermillion River drains 3712 km² (1434 mi²) of largely agricultural land. Its three major tributaries coalesce near Danville, Illinois. Salt Fork and Middle Fork join at River Mile 29 and North Fork enters at RM 23 just upstream from a dam. The Middle Fork is regarded as one of Illinois's finest streams (18) and harbours several unusual species of fish. The upper tributaries of Salt Fork have been the subject of many investigations (9, 10, 11, 15) and suffers domestic sewage from the cities of Rantoul and Champaign-Urbana as well as agricultural runoff. North Fork is somewhat polluted below Lake Vermillion (18).

We investigated the lower 46 km (29 mi.) which, in addition to the waters mentioned, also received drainage from old coal mines and the industrial and domestic wastes from Danville, Ill. (17). Smith (18) stated that this section of the river is "badly polluted . . . , but recovers before it leaves the state." The lower 8 km (5 mi.) exhibits considerable lateral erosion in passing through agricultural fields before joining the Wabash River. The mean rate of fall in the lower reach is about 0.40m/km (2.1 ft/mi).

Sugar Creek is essentially linear in its drainage, flowing about 90 miles from its headwaters in central Indiana westward to the Wabash River and having a mean rate of fall of 0.87m/km (5.1 ft/mi). Its drainage basin is 2100 km² (811 mi²). Diffuse nonpoint agricultural influence occurs in the upper half of the basin and also in the lower 16 km (10 mi), but domestic sewage from Crawfordsville is the only major point-source of influence in the basin. From RM 30 to Rm 10 Sugar Creek flows through a rugged, forested region which includes Pine Hills State Nature Preserve, Shades State Park, and Turkey Run State Park. Some agricultural fields exist in suitable areas, but they are usually well buffered from the Creek by a wooded corridor. The lower 16 km (10 mi.) of Sugar Creek exhibits considerable lateral erosion. A very limited potential for coal mine runoff exists in the extreme lower portion of the stream.

The distribution of fishes in Sugar Creek prior to 1945 is documented by Gerking (7). More recently, Huffaker (8) has examined the fish populations.

Methods

In 1979, eight collecting stations of 0.5 km length were located within the

lower 30 km of the Big Vermilion River. Each of these stations was sampled three times using a Smith-Root Type VI D.C. electrofishing unit which pulsed 120/sec through an electrode system mounted in a 16 ft Jon boat. This same unit was used regularly on the Wabash River, but the low late summer flow of Big Vermilion River made it difficult to move about. Therefore, in 1980 the same apparatus used on Sugar Creek, a battery powered D.C. unit mounted in a rowing canoe was used to collect fish from the same stations and an additional five which extended the study to the lower 46 km.

In 1979, a total of 19 collecting stations were sprinkled through the lower 80 km of Sugar Creek from Carlington to the mouth. This was reduced to 11 stations in the lower 40 km in 1980 from Deer Mill to Cox Ford bridge. Each station was located in swifter sections of the streams with good bottom cover and moderate depths. Each station was sampled three times in both years.

Electrofishing was conducted near shore and cover in a downstream direction. Netted fish were placed in a livewell and measured, weighed, and identified shortly after being collected and then returned to the water. A few small fish of uncertain identification were placed in 10% formalin and returned to the laboratory for later examination. Several taxonomic keys were used to identify fish (20,2,14,19).

The data from each catch was entered into a computer data file and analyzed for the following parameters:

- (1) Shannon-Weaver Index of Diversity (H) (12)

$$\bar{H} = - \sum \frac{(n_i)}{N} \ln \frac{(n_i)}{N}$$

where n_i = numbers or weight for individual species per km electrofished

N = total number of individuals or total weight

$\ln$ = natural logarithm

- (2) Evenness (J) (13):

$$J = \frac{\bar{H}}{\ln S}$$

where $\bar{H}$ = Shannon-Weaver index of diversity based on numbers or weights

S = total number of species in sample

$\ln$ = natural logarithm

- (3) No/km: relative abundance measured as number of individuals caught per km electrofished

- (4) Kg/km: relative abundance measured as aggregate weight of fish caught per km electrofished

- (5) Composite Index of Well-Being (I_{wb}) (4, 5)

$$I_{wb} = 0.5 \ln(\text{No/km}) + 0.5 \ln(\text{kg/km}) + \bar{H}_{(no.)} + \bar{H}_{(wt.)}$$

where No/km = number individuals per kilometer electrofished

Kg/km = total weight per kilometer electrofished

$\bar{H}_{(no.)}$ = Shannon-Weaver index of diversity based on numbers

$\bar{H}_{(wt.)}$ = Shannon-Weaver index of diversity based on weights

Results

Sampling effort for the two streams was quite comparable with 63 samples

taken for a total sampling distance of 31.5 km from Big Vermilion River and 76 samples taken for 29.6 km from Sugar Creek. Forty species were collected from Big Vermilion River and 48 from Sugar Creek (Table 1). More fish were collected from Sugar Creek than from Big Vermilion River (2148 compared to 999), but they were much smaller on the average (10.2 g/individual compared to 35.6 g/individual), so that a much greater aggregate weight of fish was collected from Big Vermilion River.

TABLE 1: List of fishes collected by electrofishing Big Vermillion River and Sugar Creek during 1979 and 1980.

Family and Scientific Name	Common Name	Big Ver- milion R.	Sugar Creek
Petromyzontidae (Lampreys)			
<i>Ichthyomyzon unicuspis</i>	Silver lamprey	X	
<i>Lampetra appendix</i>	Amer. brook lamprey		X
Acipenseridae (Sturgeons)			
<i>Scaphirhynchus platyrhynchus</i>	Shns. sturgeon	X	
Lepisosteidae (Gars)			
<i>Lepisosteus osseus</i>	Longnose gar	X	X
<i>Lepisosteus platostomus</i>	Shortnose gar	X	X
Amiidae (Bowfins)			
<i>Amia calva</i>	bowfin		X
Clupeidae (Herrings)			
<i>Dorosoma cepedianum</i>	Gizzard shad	X	X
<i>Alosa chrysochloris</i>	Sj. herring	X	X
Hiodontidae (Mooneyes)			
<i>Hiodon tergisus</i>	Mooneye	X	
Esocidae (Pikes)			
<i>Esox americanus</i>	Grass pickerel	X	X
Cyprinidae (Minnows)			
<i>Campostoma anomalum</i>	Stoneroller	X	X
<i>Cyprinus carpio</i>	Carp	X	X
<i>Ericymba buccata</i>	Silverjaw minnow	X	X
<i>Hybopsis amblops</i>	Bigeye chub	X	X
<i>Hybopsis x-punctata</i>	Gravel chub	X	X
<i>Nocomis micropogon</i>	River chub		X
<i>Notropis blennioides</i>	River shiner	X	X
<i>Notropis atherinoides</i>	Emerald shiner	X	X
<i>Notropis rubellus</i>	Rosyface shiner	X	X
<i>Notropis spilopterus</i>	Spotfin shiner	X	X
<i>Notropis stramineus</i>	Sand shiner	X	X
<i>Phenocobius mirabilis</i>	Suckermouth minnow	X	X
<i>Pimephales notatus</i>	Bluntnose minnow	X	X
<i>Semotilus atromaculatus</i>	Creek club	X	X
<i>Notropis chrysocephalus</i>	Striped shiner	X	X
<i>Notropis whiplii</i>	Steelcolor shiner		X
Catostomidae (Suckers)			
<i>Carpionodes carpio</i>	River carpsucker	X	X
<i>Carpionodes cryprinoides</i>	Quillback	X	X
<i>Carpionodes verifer</i>	Highfin carpsucker	X	X
<i>Catostomus commersoni</i>	White sucker		X
<i>Hypentelium nigricans</i>	No. hog sucker	X	X
<i>Ictiobus bubalus</i>	Smallmouth buffalo	X	
<i>Minytrema melanops</i>	Spotted sucker		X
<i>Moxostoma anisurum</i>	Silver redhorse	X	X
<i>Moxostoma duquesnei</i>	Black redhorse	X	X
<i>Moxostoma erythrurum</i>	Golden redhorse	X	X
<i>Moxostoma macrolepidotum</i>	Sh. redhorse	X	X
Ictaluridae (Catfishes)			
<i>Ictalurus natalis</i>	Yellow bullhead	X	X

TABLE 1.—Continued

Family and Scientific Name	Common Name	Big Ver- million R.	Sugar Creek
<i>Ictalurus punctatus</i>	Channel catfish	X	X
<i>Noturus miurus</i>	Brindled madtom	X	X
<i>Pylodictis olivaris</i>	Flathead catfish	X	X
Percichthyidae (Basses)			
<i>Morone chrysops</i>	White bass	X	X
Centrarchidae (Sunfishes)			
<i>Ambloplites rupestris</i>	Rock bass	X	X
<i>Lepomis macrochirus</i>	Bluegill	X	X
<i>Lepomis megalotis</i>	Longear sunfish	X	X
<i>Micropterus dolomieu</i>	Smallmouth bass	X	X
<i>Micropterus punctulatus</i>	Spotted bass	X	X
<i>Pomoxis annularis</i>	White crappie	X	X
<i>Pomoxis nigromaculatus</i>	Black crappie		X
Percidae (Perches)			
<i>Etheostoma blennioides</i>	Greenside darter	X	X
<i>Percina caprodes</i>	Logperch	X	X
<i>Percina maculata</i>	Blackside darter	X	X
<i>Percina phoxocephala</i>	Slenderhead darter	X	X
<i>Percina sciera</i>	Dusky darter	X	X
<i>Stizostedion canadense</i>	Sauger	X	
<i>Stizostedion vitreum</i>	Walleye		X
Sciaenidae (Drum)			
<i>Aplodinotus grunniens</i>	Freshwater drum	X	

Between 82% and 88% of the catches from both streams were made up of the same 14 species of fish (Table 2). Gizzard shad were equally abundant in both streams, but the relative abundance of most other species was quite different. Catches from Sugar Creek were dominated by hog suckers, black and golden redhorse, river chub, spotfin and striped shiners, longear sunfish, and smallmouth bass. Catches from Big Vermilion River were dominated by carp and northern river carpsucker.

TABLE 2: Catch rates of the 14 most common species.

Species	Sugar Creek		Big Vermilion R.	
	No/km	Kg/km	No/km	Kg/km
Gizzard shad	13.70	0.90	13.14	1.12
Spotfin shiner	12.69	0.07	1.24	0.01
Northern hog sucker	9.42	1.41	1.75	0.26
River chub	6.85	0.23	0	0
Black redhorse	4.52	1.07	0.38	0.10
Striped shiner	3.34	0.06	0	0
Golden redhorse	3.21	0.82	1.91	0.71
Longear sunfish	2.87	0.14	1.68	0.09
Smallmouth bass	2.57	0.35	0.64	0.08
Stoneroller	2.06	0.03	0	0
Bluntnose minnow	1.59	0.01	0.67	0.01
Northern river carpsucker	0.03	0.02	3.02	2.27
Highfin carpsucker	0.10	0.03	0.32	0.15
Carp	0.44	0.87	2.73	5.16
Other species	9.10	1.40	4.23	1.32
Totals	72.49	7.39	31.71	11.28

Many more different species of Cyprinidae were collected from Sugar Creek than from Big Vermilion River, which may account in part for the much greater number of species taken per collection in the former stream (Table 3). Calculated diversities, evenness, and the composite index were also substantially higher in Sugar Creek.

TABLE 3: *Community statistics for electrofishing catches from Sugar Creek and Big Vermilion River (± 1 S.E.).*

Parameter	Sugar Creek	Big Vermilion R.
No./Km.	72.32(5.93)	31.71(3.35)
Kg/Km.	7.42(0.60)	11.28(1.72)
Ave. No. species/collection	8.22(0.44)	4.92(0.32)
Shannon diversity (no.)	1.67(0.06)	1.15(0.07)
Shannon diversity (wt.)	1.36(0.06)	0.87(0.07)
Evenness (no.)	0.84(0.01)	0.71(0.04)
Evenness (wt.)	0.67(0.02)	0.53(0.04)
Composite index	5.86(0.20)	4.30(0.26)

The data also provide a trophic analysis when each species of fish is assigned to a predominant feeding category on the basis of literature evidence (3, 16, 14, 1, 19). Based upon weight, the fish population of Big Vermilion River is dominated by omnivores (46.4%) and detritivores (22.6%), while Sugar Creek is dominated by insectivores (51.3%) (Table 4). A much greater proportion of the catch by weight consisted of piscivores, species of special interest to fishermen, in Sugar Creek (16.6%) than in Big Vermilion River (6.1%).

TABLE 4: *Trophic composition (%wt) of the electrofishing catches of fish from Sugar Creek and Big Vermilion R.*

Feeding Guild	Sugar Creek	Big Vermilion R.
Piscivores	16.6	6.1
Insectivores	51.3	14.9
Herbivores	12.6	9.9
Omnivores	17.7	46.4
Detritivores	1.7	22.6

Discussion

The combined influence of several factors accounts for the differences in the fish communities of Big Vermilion River and Sugar Creek. Big Vermilion River contains more species characteristic of large rivers, such as shovelnose sturgeon, shortnose gar, drum, and smallmouth buffalo, although at low flow the two streams are not that different in size. The lower gradient of Big Vermilion River leads to the development of long pools with short riffles scattered at intervals of one to three miles. The quality of habitat is generally much lower in Big Vermilion River than in Sugar Creek although for at least one-third of the collecting stations habitat quality was subjectively judged on a par with that of Sugar Creek.

These factors no doubt have some influence on the fish community of Big Vermilion River, but cannot entirely account for the very low composite index

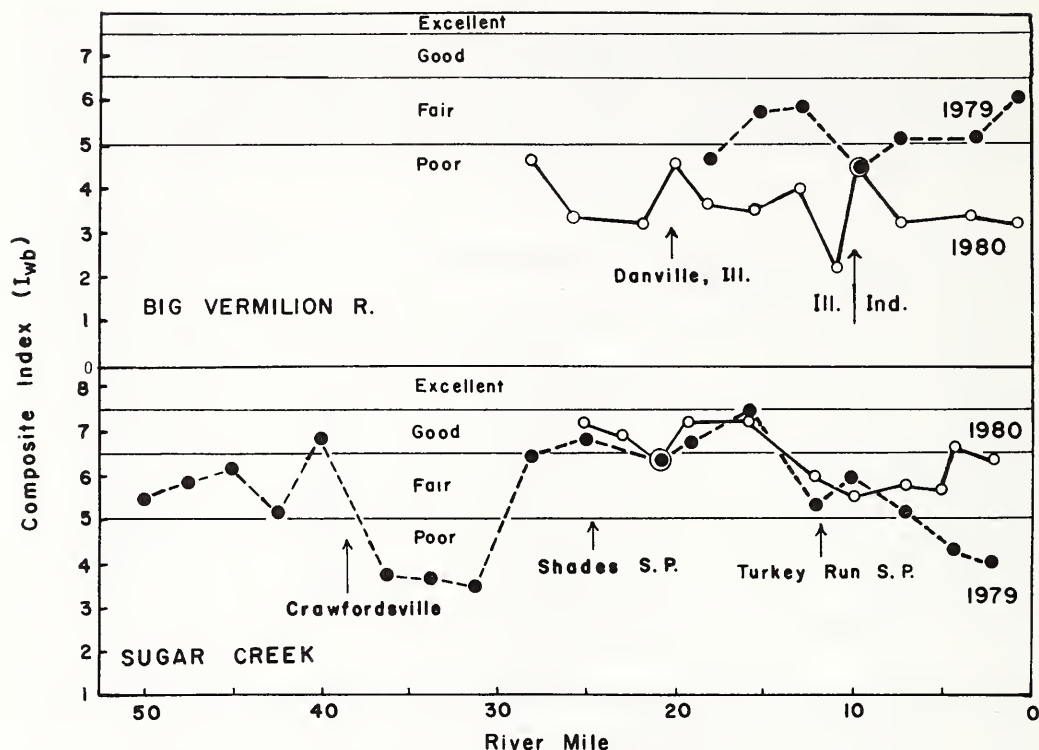


FIGURE 1: Composite index profile for Big Vermilion River and Sugar Creek.

values noted throughout the lower stream (Figure 1) which generally indicate poor to degraded environmental conditions (5). Even upstream from Danville, Ill. the fish community gives evidence of stress, probably the result of poor water quality from Salt Fork since habitat quality was excellent. In the Danville area itself, trash litters the river banks, industrial fumes cut through the woodland smells, old barren strip mines slope nearby, and a green scum of algae develops in slow-water regions during low-flow. Visual improvements occur downstream, but environmental quality and fish communities do not. There is no evidence that the river improves with distance from Danville. Perhaps any improvements in water quality are offset by the increased lateral erosion so strongly evident in the lower five miles.

In summary, the fish communities of lower Big Vermilion River are unworthy of the beautiful, wooded valley through which it flows. There is no doubt that the environmental degradation of the Big Vermilion River ultimately extends into the Wabash River into which it flows. Potentially the river is a valuable recreational asset, but the problems besetting its waters are widespread and complex and it is unrealistic to expect their solution in the near future.

Unlike Big Vermilion River, Sugar Creek is relatively insulated from the encroachment of man throughout most of its lower length, but the same problems afflict it to a less extensive degree. The best fish communities are located in 15 miles of stream in the Shades and Turkey Run State Park area, fish communities which are perhaps as good as any in the state of Indiana at this time in terms of population abundance, number of species, diversity and density of game species. Nearly 23% of the catch here consisted of gamefish species, with a particular abundance of smallmouth bass.

The communities are less good in the 10 miles of stream between Darlington and Crawfordsville, although since the 1979-80 collections improvements have been

made in the waste treatment process at Darlington. There was no indication that the municipal electric generating plant at Crawfordsville influenced the fish, but the stream was strongly degraded for 10 miles downstream from the Crawfordsville sewage treatment plant. After recovery has occurred in the vicinity of the state parks another zone of degradation occurs in the lower 15 miles of the stream largely because of agriculture.

Some tributaries in this lower section carry large quantities of silt and fertilizers into Sugar Creek. A notable example is a small creek which enters from the north just above the narrows near Turkey Run State Park which was usually choked by mud. In addition, as the river flows west from U.S. 41 it enters a broad shallow valley where fields extend up to the bank and lateral erosion is strongly evident. The depression of the fish communities from these entirely agricultural activities generally termed as nonpoint source pollution is fully as extensive as from the point source of Crawfordsville.

Sugar Creek is an outstanding recreational resource, providing pleasure for thousands of campers, canoeists, and fishermen. Recent improvements in waste treatment at the state parks and Darlington will help maintain the value of Sugar Creek. Improved waste treatment at Crawfordsville is needed and an extensive program aimed at reducing sheet and lateral erosion in the agricultural fields in the lower valley is also clearly indicated in the future to prevent further degradation. Probably the upper, eastern part of the watershed should be examined to assess problem areas here also. Overall, Sugar Creek is in fair to good environmental condition and every effort should be made to keep or, in places, improve its present quality.

Unfortunately, the impact of agriculture in the lower 10 or so miles means that Sugar Creek is not the positive factor it might be with respect to the environment of the Wabash River. Nevertheless, on at least one occasion this stream served as a vital refuge for fish trying to survive low dissolved oxygen concentrations in the Wabash River itself (6).

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Editor's Note: The various spellings (Vermilion/Vermillion) are in agreement with the different spellings used on both Indiana and Illinois maps.

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