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CHANGES IN THE FISH COMMUNITY OF THE EEL RIVER RESULTING FROM AGRICULTURE

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ABSTRACT: Fish communities and habitat at 25 sites located throughout the Eel River mainstem and 6 tributaries were studied during the summer of 1990 using a 3/16 inch mesh, 30 ft by 4 ft seine to collect small fish and a backpack electrofisher. Comparisons were made with studies over the past 50 years. The 1990 fish community was improved compared to the 1982 community, perhaps because of an intervening series of years when both river discharge and suspended sediment concentrations were lower than normal. Over a longer perspective the fish community is degraded. Many species common 50 years ago are now either absent or very severely reduced in distribution and abundance. Rainbow darter, orangethroat darter, bluebreast darter, and stonecat were not collected at all. Mottled sculpin, greenside darter, blackside darter, silver shiner, rosyface shiner, longear sunfish, and smallmouth bass were very restricted in their distribution.

INTRODUCTION

The current study was conducted under contract with the Indiana Department of Environmental Management to examine existing fish communities and compare them with those found by Gerking (1945), Taylor (1972), and Braun and Robertson (1982). It included an evaluation of instream and nearstream habitat from the standpoint of agricultural nonpoint sources of pollution and its possible influence on those fish communities. Morrison (1977, 1981), Schlosser and Karr (1981), and Karr, *et al.* (1987) studied the effects of agriculture on other stream ecosystems.

Exerting roughly equivalent effort and similar methods, Braun and Robertson (1982) found only 3 smallmouth bass from the Eel River in northern Indiana compared to 96 bass captured 11 years earlier by Taylor (1972). Smallmouth bass populations were augmented by stocking over 17,000 fin-clipped fingerlings from 1983 through 1986 by the Indiana Department of Natural Resources (IDNR). Several stations in the extreme lower river and in tributaries were intensively sampled during this period. This severe reduction in number of individuals suggests a significant change in the ability of the Eel River to sustain a quality fish community.

THE EEL RIVER

The Eel River is located in northwest Allen County near Ft. Wayne; it flows southwest for approximately 177 km (110 mi) through Kosciusko, Whitley, Wabash, and Miami Counties into the Wabash River at Logansport in Cass County. Its rate of descent is 0.457 m/km (2.41 ft/mile) with a lower rate in the upper third and a slightly higher rate in the lower 20 km.

This area originally contained glacial lakes and swampy wetlands, but it was extensively ditched and drained prior to 1900 for agricultural use. Approximately 79% of its 2,148 km^2 (814 m^2) drainage basin area (Hoggatt, 1975) is devoted to rowcrop agriculture, primarily corn and soybeans. Most of the smaller tributaries and the upper river have been channelized to facilitate drainage. Low mill dams have been constructed at

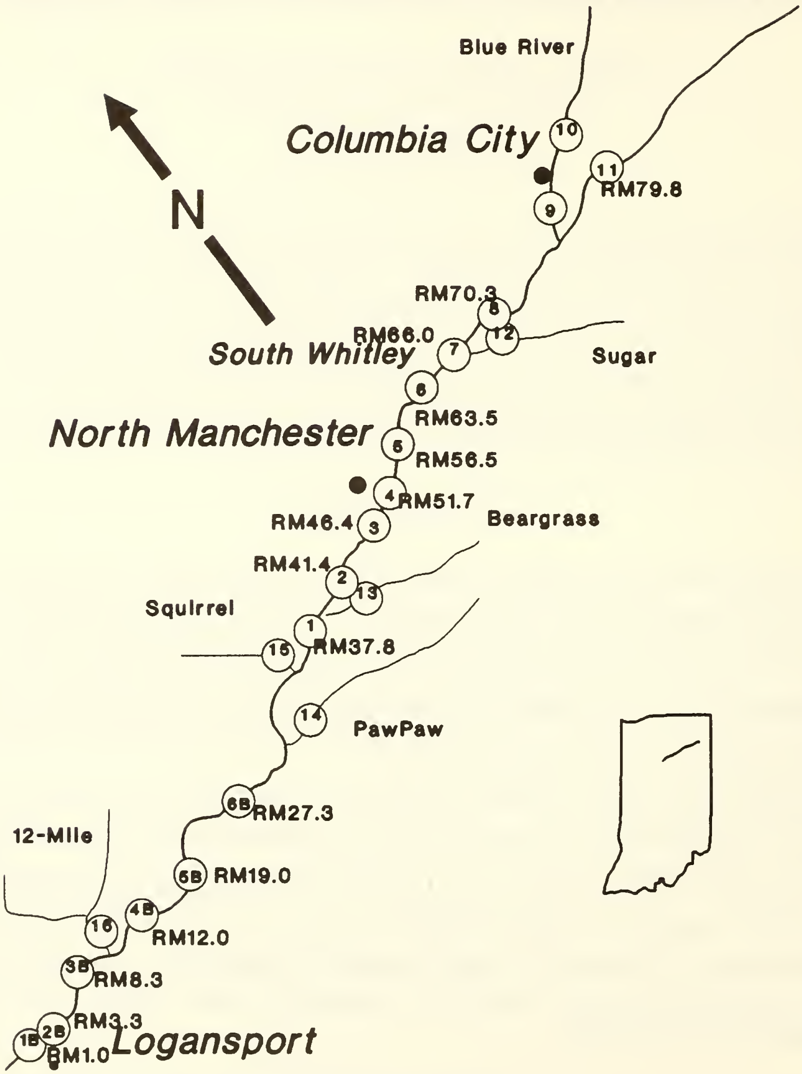

Figure 1. Map of the Eel River and main tributaries with locations of collecting sites.

various locations. Many of these dams are disintegrating except for the Logansport dam near the mouth of the Eel River.

MATERIALS AND METHODS

The study objectives included 1) a reconnaisance float trip of the entire river, 2) sampling each station twice by electrofishing, 3) sampling many of these same stations on one separate occassion by seining, and 4) a habitat survey (HEP) at each station. Secchi

Table 1. Habitat assessment scoring criteria (HEP).

Habitat Parameter	Condition			
	Excellent	Good	Fair	Poor
Primary Influence				
Substrate and Instream Cover				
1. substrate/cover	16-20	11-15	6-10	0-5
2. embeddedness	16-20	11-15	6-10	0-5
3. water velocity	16-20	11-15	6-10	0-5
Secondary Influence				
Channel Morphology				
4. channel alteration	12-15	8-11	4-7	0-3
5. scouring/deposition	12-15	8-11	4-7	0-3
6. pool/riffle ratio	12-15	8-11	4-7	0-3
Tertiary Influence				
Riparian and Bank Structure				
7. bank stability	9-10	6-8	3-5	0-2
8. bank vegetation	9-10	6-8	3-5	0-2
9. bank cover	9-10	6-8	3-5	0-2

transparency and temperature were routinely measured on each occasion. In addition, synoptic short-term profiles of turbidity, temperature, and dissolved oxygen concentration were determined on three separate dates.

Single stations were located on lower Twelve Mile, Paw Paw, Squirrel, Beargrass, and Sugar Creeks, and also upstream and downstream of Columbia City on the Blue River (Figure 1). The remaining 16 stations were located on the mainstem of the Eel River. Some mainstem stations (Taylor's 2B, 2, and 3) and Squirrel Creek were not seined because of inappropriate habitat.

Seining was conducted with a 30-foot by 4-foot seine having 3/16 inch mesh weighed down by a heavy steel chain tied to the bottom. This method was very effective at capturing darters and minnows. Three seining passes along 20 m of shoreline constituted each seine sample.

Electrofishing utilized a Safari Bushman 300 backpack shocker carried in a canoe or while wading, depending on place and depth. Each electrofishing sample was about 20 minutes in duration along approximately 400 meters of shoreline. This method was effective in capturing larger fish such as redhorse and nearshore species including sunfish and bass.

All captured fish were identified to species, weighed, and measured, and most were then released unharmed. Those fish not easily identified in the field were preserved in formalin and returned to the laboratory for identification (Trautman, 1981).

Fish data were analyzed using the index of well-being (Iwb) and the index of biotic integrity (IBI). The 1990 Iwb values were based upon the average of two electrofishing catches at each station. The rationale of this community parameter is presented by Gammon (1980), who recommended multiple collections at each site.

The Iwb was calculated as:

$$Iwb = 0.5 \ln N + 0.5 \ln W + \text{Div. no.} + \text{Div. wt.},$$

where N equals the number of fish captured per km, W equals the weight in kg of fish captured per km, Div. no. equals the Shannon diversity based on numbers, and Div. wt. equals the Shannon diversity based on weight.

The IBI methodology, thoroughly discussed by Karr (1981, 1987), Karr, *et al.* (1986, 1987), and Angermeier and Karr (1986), was modified slightly by expanding the metric dealing with number of species to make it consistent with the Sugar Creek study (Gammon, *et al.*, 1991) and an agricultural analysis of several streams in west-central Indiana (Gammon, *et al.*, 1990). The 1990 IBI values were based upon the combined catches from electrofishing and seining. The IBI values calculated on data from earlier Eel River studies may be influenced to an unknown degree by the somewhat different methodologies used to collect fish. Taylor (1972) used a combination of electrofishing and rotenone, while Braun and Robertson (1982) used more intensive electrofishing. We have elected to use the same criteria regardless of stream order.

Habitat was quantitatively evaluated at each mainstem collecting site, except for the most downstream site near the Logansport dam and Taylor's site 1, using a habitat evaluation procedure (HEP) (Plafkin, *et al.*, 1989) adapted from Platts, *et al.* (1987). HEP quantifies 9 habitat characteristics summarized in Table 1. The total score for each site was based upon data from 10 transects at each site spaced 25, 50, or 100 feet apart.

In addition, several other physical measurements were taken whenever fish collections were made and also in special longitudinal surveys. Stream turbidity was measured with a secchi disc and/or a B&L Minispec20 nephelometer. Water temperatures and dissolved oxygen readings were obtained using a YSI meter. Water velocity was measured using a Gurley pygmy meter. All distances were measured optically using a Leitz rangefinder.

Estimates of the amount of woodland were based on conventional analyses of enlarged LandSat infrared photographs taken on May 2, 1981. These were obtained from U.S. Geological Survey (ESIC), EROS Data Center, Sioux Falls, South Dakota.

The drainage area perimeter was determined using topographic maps of tributaries. This scaled map was superimposed over the infrared photographs on a light table. Plots of land with permanent tree cover were outlined on the topographic map.

The marked topographic map was traced onto a fine grid using a light table. Individual grids with more than 50% woodland were marked. Grid totals were counted and the percentage woodland was calculated. Land use in a few tributaries was not determined because of insufficient coverage of LandSat infrared photographs.

RESULTS

A total of 6,635 fish comprising 46 species were captured by electrofishing and seining (Table 2). Forty species and 4154 individuals (63%) were taken by seining alone. Electrofishing catches also yielded 40 species, but only 2481 individuals or 37% of the total.

Bluntnose minnow (*Pimephales notatus*) was very common with 40.9% of the total number seined, while sand shiner (*Notropis stramineus*), spotfin shiner (*N. spilopterus*), common shiner (*N. cornutus*), silverjaw minnow (*Ericymba buccata*), and creek chub

Table 2. Species of fish collected from the Eel River and tributaries.

Family & Common Name (Scientific Name)	1945[a]	1972	1982	1990
Lampreys – Petromyzontidae				
Am. Brook lamprey (*Lampeta lamottei*)		x		
Chestnut lamprey (*Ichthyomyzon castaneus*)			x	
Gar Family – Lepisosteidae				
Longnose gar (*Lepisosteus osseus*)	x			
Herring Family – Clupeidae				
Gizzard shad (*Dorosoma cepedianum*)	x	x	x	x
Mudminnow Family – Umbridae				
Mudminnow (*Umbra limi*)	x	x	x	x
Pike Family – Esocidae				
Grass pickerel (*Esox vermiculatus*)	x	x	x	x
Northern pike (*Esox lucius*)	x			
Minnow Family – Cyprinidae				
Carp (*Cyprinus carpio*)		x	x	x
Stoneroller (*Campostoma anomalum*)	x	x	x	x
Silverjaw minnow (*Ericymba buccata*)	x	x	x	x
W. silvery minnow (*Hybognathus nuchalis*)	x			
Creek chub (*Semotilus atromaculatus*)	x	x	x	x
Hornyhead chub (*Nocomis biguttatus*)	x	x	x	
River chub (*Nocomis micropogon*)	x	x		x
Silver chub (*Hybopsis storeriana*)	x			
Bigeye chub (*Hybopsis amblops*)	x	x		x
Speckled chub (*Hybopsis aestivalis*)	x			
Suckermouth minnow (*Phenacobius mirabilis*)	x	x	x	x
Emerald shiner (*Notropis atherinoides*)	x		x	
Common shiner (*Notropis cornutus*)	x	x	x	x
Silver shiner (*Notropis photogenis*)	x	x		x
Spotfin shiner (*Notropis spilopterus*)	x	x		x
Blackchin shiner (*Notropis heterodon*)			(x)[b]	
Sand shiner (*Notropis stramineus*)	x			x
Rosyface shiner (*Notropis rubellus*)	x	x		x
Redfin shiner (*Notropis umbratilis*)	x	x		x
Steelcolor shiner (*Notropis whipplii*)	x		x	

Family & Common Name (Scientific Name)	1945[a]	1972	1982	1990
Bluntnose minnow (*Pimephales notatus*)	x	x	x	x
Fathead minnow (*Pimephales promelas*)			x	x
Bullhead minnow (*Pimephales vigilax*)	x			
Blacknose dace (*Rhinichthys atratulus*)	x	x	x	x
So. redbelly dace (*Phoxinus erythrogaster*)	x			
Golden shiner (*Notemigonus crysoleucas*)	x			
Sucker Family – Catostomidae				
Quillback carpsucker (*Carpiodes cyprinus*)		x	x	x
Highfin carpsucker (*Carpiodes velifer*)	x			
Black redhorse (*Moxostoma dequesnei*)		x	x	x
Golden redhorse (*Moxostoma erythrurum*)	x	x	x	x
Greater redhorse (*Moxostoma valenciennesi*)	x		x	x
Silver redhorse (*Moxostoma anisurum*)			(x)[b]	
River redhorse (*Moxostoma carinatus*)			(x)[b]	
No. hog sucker (*Hypentelium nigricans*)	x	x	x	x
White sucker (*Catostomus commersoni*)	x	x	x	x
W. creek chubsucker (*Erimyzon oblongus*)	x	x	(x)[b]	
Spotted sucker (*Minytrema melanops*)	x	x	x	x
Catfish Family – Ictaluridae				
Yellow bullhead (*Ictalurus natalis*)		x	x	x
Black bullhead (*Ictalurus melas*)	x	x	x	x
Channel catfish (*Ictalurus punctatus*)	x	x	x	x
Stonecat (*Noturus flavus*)	x		(x)[b]	
Tadpole madtom (*Noturus gyrinus*)	x	x		
Furious madtom (*Noturus furiosus*)	x			
Brindled madtom (*Noturus miurus*)		x		
Eel Family – Anguillidae				
American eel (*Anguilla rostrata*)	x		(x)[b]	
Pirate Perch Family – Aphredoderidae				
Pirate perch (*Aphredoderus sayanus*)	x			
Killifish Family – Cyprinodontidae				
Blackstripe topminnow (*Fundulus notatus*)	x	x		x
Banded killifish (*Fundulus diaphanus*)			x	

Family & Common Name (Scientific Name)	1945[a]	1972	1982	1990
Sunfish Family – Centrarchidae				
Smallmouth bass (*Micropterus dolomieui*)	x	x	x	x
Spotted bass (*Micropterus punctulatus*)				x
Largemouth bass (*Micropterus salmoides*	x	x	x	x
Green sunfish (*Lepomis cyanellus*)	x	x	x	x
Pumpkinseed (*Lepomis gibbosus*)	x	x	x	x
Longear sunfish (*Lepomis megalotis*)	x	x	x	x
Orangespot sunfish (*Lepomis humilis*)	x	x	x	
Bluegill (*Lepomis macrochirus*)		x	x	x
Rock bass (*Ambloplites rupestris*)	x	x	x	x
White crappie (*Pomoxis annularis*)	x	x		x
Black crappie (*Pomoxis nigromaculatus*)		x		
Perch Family – Percidae				
Logperch (*Percina caprodes*)	x	x		
Gilt darter (*Percina evides*)	x			
Blackside darter (*Percina maculata*)	x	x		x
Slenderhead darter (*P. phoxocephala*)	x			
River darter (*Percina shumardi*)			x	
No. dusky darter (*Percina sciera*)				x
East. sand darter (*Ammocrypta pellucida*)	x		(x)[b]	x
Greenside darter (*Etheostoma blennioides*)	x	x		x
Rainbow darter (*Etheostoma caeruleum*)	x			
Bluebreast darter (*Etheostoma camurum*)	x			
Fantail darter (*Etheostoma flabellare*)	x			x
Least darter (*Etheostoma microperca*)	x			
Johnny darter (*Etheostoma nigrum*)	x	x		x
Orangethroat darter (*Etheostoma spectabile*)	x	x		
Sculpin Family – Cottidae				
Mottled sculpin (*Cottus bairdi*)	x	x		x

[a] Includes all collections prior to 1945.

[b] Captured in 1984 and/or 1985 (Braun, Robertson, and Stefanavage, 1984, 1986).

Table 3: Fish community indices for Eel River stations.

Station		1990	No.	Spec.	Elec.	IBI		
Taylor	Rkm	Iwb	1972	1982	1990	1972	1982	1990
Mainstem Stations								
1B	1.6	5.8	12	13	15	38	44	44
2B	5.3	6.4	14	14	14	44	42	44
3B	13.4	6.7	10	11	12	40	38	50
4B	19.3	7.5	17	14	17	44	40	50
5B	30.6	5.3	14	17	18	38	40	46
6B	43.9	7.5	11	12	16	40	44	42
7B	51.5	5.4	17	10	-	44	36	-
1	60.8	6.7	14	8	10	38	32	42
2	66.1	6.1	18	9	17	42	34	44
3	74.7	7.2	16	11	13	46	36	44
4	83.2	5.4	10	12	16	40	40	46
5	90.9	7.2	18	13	10	44	36	40
6	102.2	6.6	13	8	13	36	36	42
7	106.2	6.6	15	9	13	36	32	40
8	113.1	6.6	12	6	16	39	28	32
11	128.4	6.7	19	9	17	42	32	40
Tributary Stations								
Twelve Mile Creek								44
Paw Paw Creek								40
Squirrel Creek								40
Beargrass Creek								40
Sugar Creek								40
Blue River upstream from Columbia City								40
Blue River downstream from Columbia City								44

(*Semotilus atromaculatus*) together contributed another 37%.

The electrofishing catch was more evenly distributed with common shiner (*N. cornutus*) and common white sucker (*Catostomus commersoni*) each contributing about 15% to the catch. Substantial numbers of the following fishes were also found: creek chub (*Semotilus atromaculatus*; 9.3%), bluntnose minnow (*Pimephales notatus*; 9%), rock bass (*Ambloplites rupestris*; 7.4%), and northern hog sucker (*Hypentelium nigricans*; 7.1%).

Smallmouth bass (*Micropterus dolomeiui*) adults and subadults were mostly found in the lower 80 km of the Eel River and only in Paw Paw and Twelve Mile Creeks among the tributaries. Catch rates were higher in the lower 50 km of river and reduced from Rkm (river kilometer) 50 to Rkm 83. Three of 12 smallmouth bass 250 mm and longer were fin-clipped, indicating that they were stocked fish. Two of these were collected by electrofishing at Rkm 61 (Taylor 1) near Roann and the other at Rkm 44 (6B) near Chili. Young-of-the-year smallmouth bass were taken only in the extreme lower part of the Eel

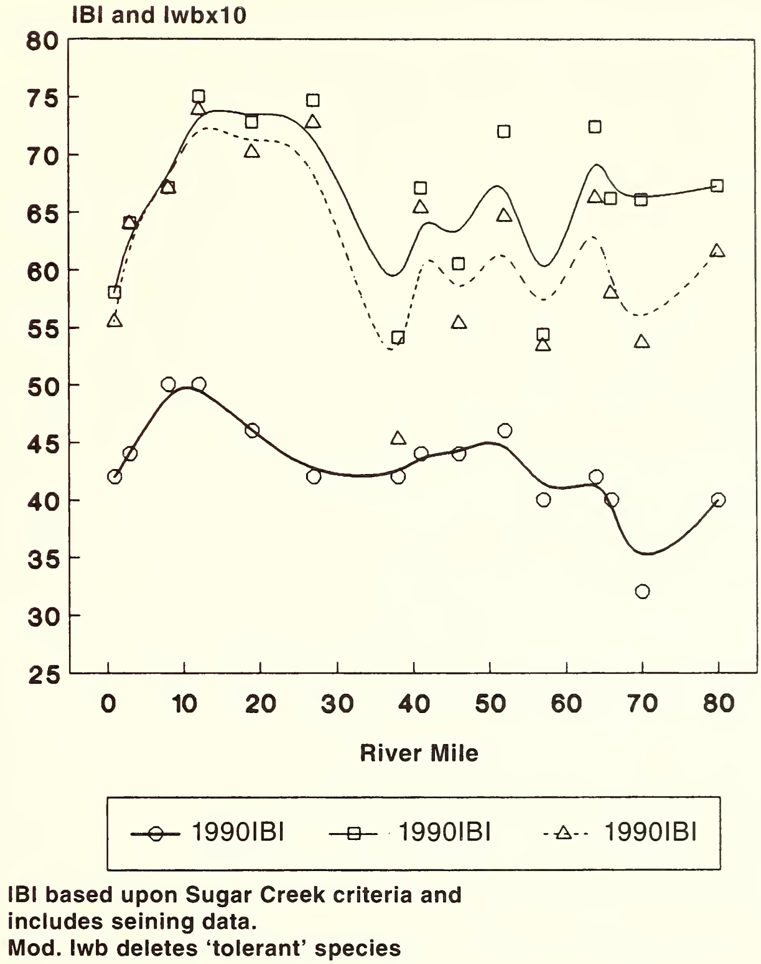

Figure 2. Profiles of IBI, Iwb, and modified Iwb for fish communities of the Eel River during 1990.

River and in Paw Paw and Twelve Mile Creeks.

Largemouth bass (*Micropterus salmoides*) formed a minor component of the catch. Fair numbers of small spotted bass (*Micropterus punctulatus*) were scattered throughout the mainstem and also in Paw Paw and Twelve Mile Creeks. This species had not been recorded for the Eel River before, although it might have been present and misidentified as small largemouth bass. Spotted bass young-of-year were found even in the poorer habitat upstream from South Whitley. This species has been shown to be tolerant of high turbidity and sedimentation (Gammon, 1970).

Rock bass (*Ambloplites rupestris*) was taken at all stations except Squirrel Creek. Longear sunfish (*Lepomis megalotis*) was most common in the upper mainstem and Blue

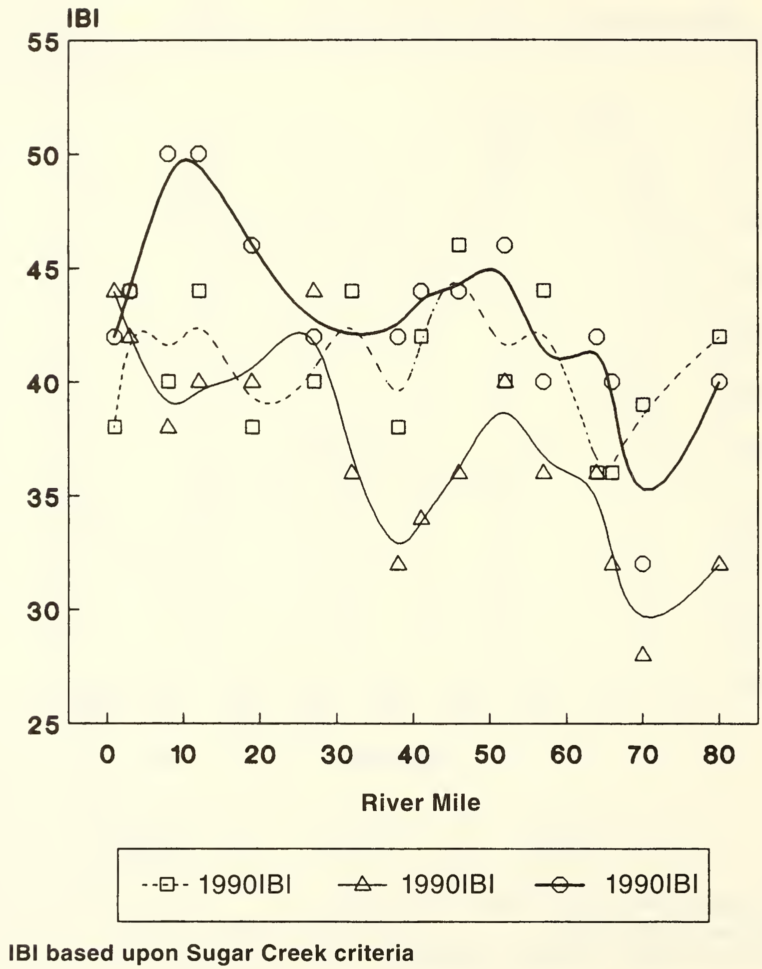

Figure 3. Mainstem IBI profiles for 1972, 1982, and 1990.

River and was sporadic in the lower river. Green sunfish (*Lepomis cyanellus*) was widely distributed, but was more abundant in the upper mainstem and in the Blue River. Many bluegill (*Lepomis macrochirus*) were mostly concentrated in the upper river.

Common white sucker (*Catostomus commersoni*) were most abundant in the upper mainstem and in Blue River, Sugar Creek, and Beargrass Creek and uncommon in the lower 100 km of mainstem. The northern hog sucker (*Hypentelium nigricans*) was widely distributed. The spotted sucker (*Minytrema melanops*) was found in good numbers only in the pool above Logansport dam.

Golden redhorse (*Moxostoma erythrurum*), although not abundant, was the most common moxostomid. It was absent between Rkm 90 and Rkm 130 as well as from all tributaries including Blue River. Black redhorse (*Moxostoma breviceps*) was mostly restricted

Table 4. Habitat quality scores for each mainstem collecting site.

Parameter	Collecting Sites 2B	3B	4B	5B	6B	1	2	3	4	5	6	7	8	11
substrate/cover	20	19	18	18	19	11	12	18	8	16	17	14	6	2
embeddedness	8	8	8	8	1	8	5	8	8	8	8	8	8	2
water velocity	19	20	19	19	20	8	14	9	8	16	11	8	8	3
channel alteration	12	7	14	14	14	12	14	14	12	12	7	5	14	14
scouring/deposition	14	13	14	14	14	14	14	14	14	13	13	14	14	14
pool/riffle ratio	13	12	11	12	10	6	6	5	4	8	7	9	3	2
bank stability	9	5	7	6	7	6	7	5	3	4	5	6	7	9
bank vegetation	9	4	7	4	6	7	7	6	4	4	3	7	7	9
bank cover	7	4	6	4	4	5	4	4	5	6	4	4	4	4
Total Score	120	92	104	99	110	77	83	83	66	87	75	75	71	59

to the lower 30 miles of river. A rare species throughout its range, a healthy population of greater redhorse (*Moxostoma valenciennesi*) thrives in the Eel River system. It was particularly abundant in the lower 32 km of river, but was also found in Paw Paw and Squirrel Creeks.

The seining catches best indicate the distribution of minnows and darters. Bluntnose minnow (*Pimephales notatus*) was most common throughout the mainstem and tributaries. Common shiner (*Notropis cornutus*) was widely distributed also, and readily taken by electrofishing. Spotfin shiner (*Notropis spilopterus*) and sand shiner (*Notropis stramineus*) mostly occurred in the lower 80 km of mainstem. Creek chub (*Semotilus atromaculatus*) was common only in tributaries. Redfin shiner (*Notropis umbratilus*) and rosyface shiner (*Notropis rubellus*) were most common in the lower river, but also occurred in Sugar and Twelve Mile Creeks. River chub (*Nocomis micropogon*) were mostly found in the lower 105 km of mainstem. A few bigeye chub (*Hybopsis amblops*) were also found here.

Among the darters, only the johnny darter (*Etheostoma nigrum*) was common and widespread. Blackside darter (*Percina maculata*), greenside darter (*Etheostoma blennioides*), and eastern sand darter (*Ammocrypta pellucida*) were found only in the lower river. Dusky darter (*Percina sciera*) was taken only from Rkm 142 and Beargrass Creek. Fantail darter (*Etheostoma flabellare*) was found only at Rkm 102.

Mottled sculpin (*Cottus bairdi*) was taken only between South Whitley and North Manchester.

Important community index values are summarized in Table 3. Mean IBI values calculated for stations 2B, 3B, and 3 from the collections of Braun, Robertson, and Stefanavage (1984, 1986) were, respectively, 39.6, 42.0, and 43.6 in 1984 and 43.2, 41.2, and 42.9 in 1985.

The IBI and Iwb profiles for the mainstem are shown in Figure 2. The modified Iwb excludes four pollution tolerant species prior to calculation (carp, bluntnose minnow, creek chub, and green sunfish). All three profiles indicate somewhat depressed fish communities in the lower river, probably because of the ponding effect of the Logansport dam, followed by relatively good communities from Rkm 13 to Rkm 40. From Rkm 48 to Rkm 129, there was much spatial variation, although communities were generally depressed, especially at Rkm 113.

Table 5. Habitat quality scores for tributaries of Eel River.

Parameter	12 Mile	Paw Paw	Squirrel	Blue River Upper	Blue River Lower	Sugar
substrate/cover	18	19	19	6	16	8
embeddedness	20	8	17	3	5	16
water velocity	15	8	19	14	10	9
channel alteration	14	14	14	14	14	14
scouring/deposition	14	14	14	14	14	14
pool/riffle ratio	9	8	11	5	4	3
bank stability	6	3	4	9	6	5
bank vegetation	7	3	3	9	6	5
bank cover	6	4	6	6	5	6
Total Score	109	81	107	80	80	80

The 1990 IBI profile is repeated in Figure 3 and compared to IBI profiles based upon Taylor's 1972 collections and the 1982 series (Braun and Robertson, 1982). The fish communities were clearly much better in 1990 than in 1982, however both indicate that better communities exist in the lower river. There was less difference between the upper and lower mainstem in 1972, but just as much spatial variation.

Habitat evaluation. Low HEP scores ranging only from 59 to 75 characterized the river upstream from South Whitley. Scores between South Whitley and Squirrel Creek ranged from 66 to 87, while those of the lower stations ranged from 92 to 120.

HEP scores of tributaries were usually higher than the mainstem reaches into which they flowed with the exception of Paw Paw Creek which was somewhat lower. The embeddedness component was very low for all mainstem and most tributary stations, i.e., fine sediments surrounded and often covered rubble and coarse gravel. At Roann, flat boulders were covered by a two cm layer of mud following a period of receding high water.

Turbidity and land use. In some streams, lateral erosion is a problem. However, scoured banks were common only in the upper 50 km of the Eel River, where trees and bushes had been stripped along both banks of the channelized river and piles of woody debris remained to be burned.

Synoptic turbidity determination on July 16 and 17, 1990 followed scattered showers of the previous week. Tributaries with high turbidity included Squirrel Creek (25 nephelometric turbidity units or NTU), Otter Creek (24 NTU), Simonton Creek (28 NTU), Hurricane Creek (37 NTU), Blue River (31 NTU), Solon Ditch (28 NTU), and Johnson Ditch (60 NTU). The Simonton watershed included a bridge under construction at the time, but animals were also pastured in the stream and some corn fields extended up to the stream banks.

Turbidity in the upper mainstem was high (45-60 NTU) mainly because of the presence of Johnson Ditch. Water cleared to about 15 NTU after passing through the mainsteam gravel pits (Rkm 135) and then became more turbid downstream (30 - 45 NTU).

There was an inverse relationship between the percentage of woodland in tributary watersheds and turbidity. Turbidity ranged from 12 to 31 NTU in tributaries 7% to 11% woodland and 5 to 20 NTU in those with more than 11% woodland. Estimated woodlands ranged from 40.9% in the Weesaw Creek watershed to only 7.0% in Beargrass Creek.

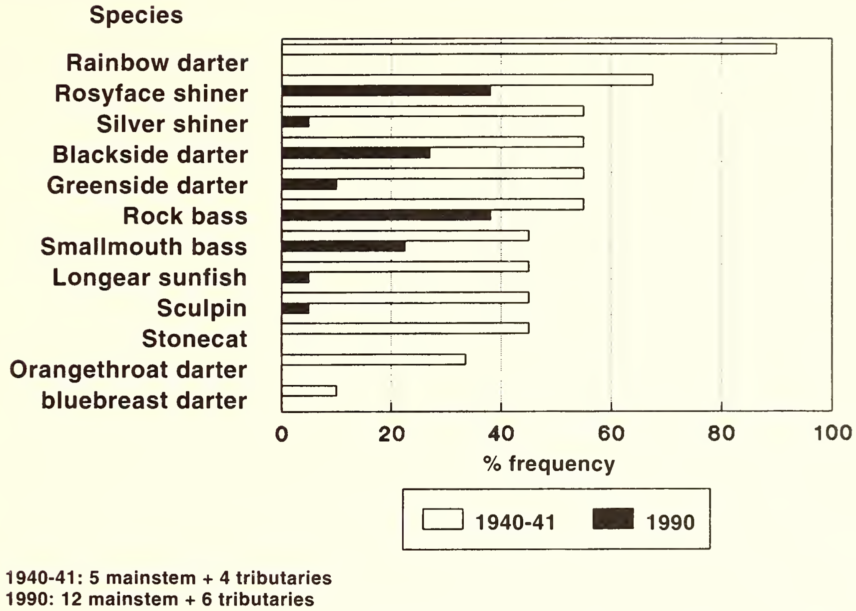

Figure 4. Changes in frequency of occurrence for some species collected by seining between 1941 and 1990.

Agricultural development was greater in the upper watershed than the lower and on the south side of the mainstem than on the north.

DISCUSSION

The fish communities of the Eel River in 1990 were fairly diverse, but the upper reaches had depressed populations and reduced numbers of species. Many species of juvenile fish were caught, with larger numbers in the lower river and in Twelve Mile Creek, an indication that reproduction for many species was successful in recent years.

The authors found some species not recorded by Braun and Robertson (1982): river chub, bigeye chub, silver shiner, spotfin shiner, rosyface shiner, redfin shiner, blackside darter, and johnny darter. Species common in 1972, but found only sparingly or not at all in 1990, included mottled sculpin, blacknose dace, madtom, suckermouth minnow, largemouth bass, and carp.

The 1990 seining effort included 12 mainstem sites and 6 tributaries compared to only 5 mainstem and 4 tributary sites visited by Gerking (1945). A comparison of frequency of occurrence for these two periods illuminates the drastic reductions which have occurred over the past 5 decades in some species populations. Rock bass, johnny darter, and sand darter are distributed much as they were 50 years ago. Many other species, however, have suffered marked declines including silver shiner, greenside darter, smallmouth bass, longear sunfish, and mottled sculpin. Stonecat, rainbow darter, orangethroat darter, and bluebreast darter may now be totally absent from the Eel River.

These declines in fish appear to parallel those experienced by clams. Henschen (1988) concluded that clams were once found throughout the Eel River but now are mostly confined to the lower river in Cass and Miami Counties.

Temporal changes are also indicated by the IBI index. Mean IBI values for mainstem stations declined from 40.7 in 1972 to 36.9 in 1982 and then increased to 43.1 in 1990. Even with this latest improvement, however, the Eel River IBI values are substantially lower than those for better quality streams such as Sugar Creek, where mainstem IBI values range from 47 to 50 (Gammon, *et al.*, 1991).

During the past decade the mean IBI values of fish communities in Big Raccoon Creek increased from 36.5 in 1981 to 50.5 in 1988. The initial low values from 1981 to 1984 probably were the result of poor reproduction and survival during summers characterized by unusually high discharge in 1979, 1981, and 1982. Darters, sunfish, and bass were almost absent during those years, but they all increased significantly by the end of the decade. The unusually high 1988 IBI value was associated with extremely low flows during a prolonged drought. Fish were undoubtedly concentrated and, therefore, much more vulnerable to capture than normal.

Unlike Big Raccoon Creek, the Eel River system has few high quality tributaries which might serve as refugia for sensitive species during unfavorable years and/or a species preserve for recolonization during favorable years. Twelve Mile Creek is a possible exception. In addition, the dam at Logansport severely hinders entry from the Wabash River. Nevertheless, spotted bass (*Micropterus punctulatus*) has somehow managed to become established.

The problems of upper Eel River are obvious and the result of long-term channelization. Here are found a disturbed channel, high turbidity and sedimentation rates, a lack of shading from riparian trees, and poor riffle-pool development. Fine sediments smother the bottom after every rainstorm.

The lower 48 km has fairly good riparian protection and instream habitat. Beds of water willow extend up to Rkm 64. Tributaries generally had better habitat than the mainstem. Twelve Mile Creek, with 26.5% of its watershed in forest, was best followed by Squirrel Creek. The Blue River is about the same size as the Eel River, where the two streams converge, but is very turbid.

Fish kills reported to the Indiana Department of Environmental Management (IDEM) since 1969 included five incidents on Paw Paw Creek and single kills on Twelve Mile, Pony, Beargrass, and Clear Creeks. The specific causal agents are unknown but may include application of animal wastes to fields, accidental drainage of waste lagoons, accidental spills, or farm chemicals, etc. Also reported were 39 spills which did not result in fish kills but which may have exerted sublethal damage. Most of these involved fertilizer and animal wastes from chicken, turkey, veal, and swine rearing operations. All fish kills and most spills originated from agricultural operations.

The Eel River may have benefitted from improved waste treatment by communities within its watershed which reduced BOD concentrations by at least 50% in recent years. Some previously unsewered communities now have a central treatment system. It is likely that any changes in these point-sources of pollution are masked by the magnitude of non-point-source pollution (NPS).

Unlike point-source pollution, NPS is most severe during periods of high rainfall and high river discharge. Conversely, NPS is reduced during periods of drought and dry weather. From the perspective of fish populations, the most serious negative effects probably occur during the reproductive period in late spring and early summer.

Based on studies from 1974 through 1980, it is estimated that the mean annual suspended sediment yield for the Eel River watershed was 178 tons/mi^2 and the flowweighted mean annual suspended sediment concentration was 89 mg/l (median = 53 mg/l) (U.S. Geological Survey, 1975-1981; Crawford and Mansue, 1988). These are high rates for this northern moraine/lake portion of Indiana which generally has low rates of sediment yield.

Using monthly USGS data from May through August for the period 1974-80, the authors determined the following relationship: suspended solids (mg/l) = 0.531 + 0.181 cfs (r = 0.738). The suspended solids (SS) loads of summer months for the past decade were then estimated. SS concentrations were highest during May and June. "Wet" summers with relatively high SS loads occurred in 1974, 1975, 1980, 1981, 1982, and 1986. "Dry" summers with low SS loads and relatively clear water occurred during 1976 through 1979, 1983 through 1985, and 1987 and 1988. Therefore, the dismal fish communities of 1982 were probably the product of unusually heavy NPS during many preceeding years, while the improved fish communities found in 1990 resulted from several preceeding years of reduced NPS. However, the improvement in the fish communities of Eel River was less than might have been expected compared to the improvement shown by Big Raccoon Creek communities.

The 1990 fish communities may be as "good" as the Eel River is capable of supporting considering present land use. The prognosis for improvement in the future is bleak unless positive changes in land use occur.

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