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EFFECTS OF ACID MINE WATER ON THE FISH POPULATIONS IN THE IRON AND BRULE RIVERS, IRON COUNTY[1]

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This report primarily concerns a follow-up investigation made on September 21-23, 1964 at the request of the Water Resources Commission, to assess recovery of fish populations in portions of the Iron and Brule rivers that had been subjected to mine-water pollution. Some of the information in reports[2] [3] on collections taken here previously is included. The following two paragraphs outline the pollution problem and summarize the fish collecting that was done on the affected areas before 1964 by field men of the Institute for Fisheries Research and the Water Resources Commission.

Discharge of highly acid water in 1962 into the Iron River from the Homer-Cardiff iron mines, located near the city of Iron River, eliminated fish for some time in this stream from the confluence of Sunset Creek to its junction with the Brule River; drastic reduction of fish also occurred at that time in the Brule River from the junction of the Iron River to the entry

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* Institute for Fisheries Research Report No. 1705.

[1] Contribution from Dingell-Johnson Project F-27-R-3, Work Plan 12, Job 4, Michigan.

[2] Institute for Fisheries Research Report No. 1674, Fish collections in the Brule-Iron river system, 1961-1962, by Wilbert C. Wagner.

[3] Letter, by T. M. Stauffer to G. P. Cooper, Effect of acid mine water on fish in the Brule and Iron rivers, Iron County, October 18, 1963.

of the Paint River (see Figure 1). Fish collections were taken with a 230-volt d-c electric shocker during December 3-5, 1962, September 17-19, 1963, and October 10, 1963 to evaluate the effects of this discharge on fish populations. Fish collections had been taken here also during October 1-5, 1961, before the areas were affected by the discharge, as part of a general fish survey of the streams. No fish were collected from the Iron River below Sunset Creek in 1962, and considerably fewer fish were taken in the Brule River than had been taken at the same stations in 1961.

Pumping of mine water into the stream ceased on February 1, 1963. The fish collecting done in September and October 1963 resulted in capture rates that were much better than those of 1962, and at some stations the rate exceeded that of 1961. Most of the increase appeared to be due to pollution abatement, but it was suspected that better conditions for collecting may also have contributed to the increased catch. The conditions for collecting fish in the first three years have been rated as follows:[4] 1961 - a relatively large volume of water and low conductivity, poor to fair collecting conditions; 1962 - smaller volume and higher conductivity but more turbid, collecting efficiency probably similar to that of 1961; 1963 - the smallest volume, high conductivity, and slight turbidity resulted in the best collecting efficiency of the three years. Data on water conditions appear in Table 1.

To determine if the recovery of the fish population persisted in the previously polluted sections of the Iron and Brule rivers, collecting

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[4] Stauffer, op. cit.

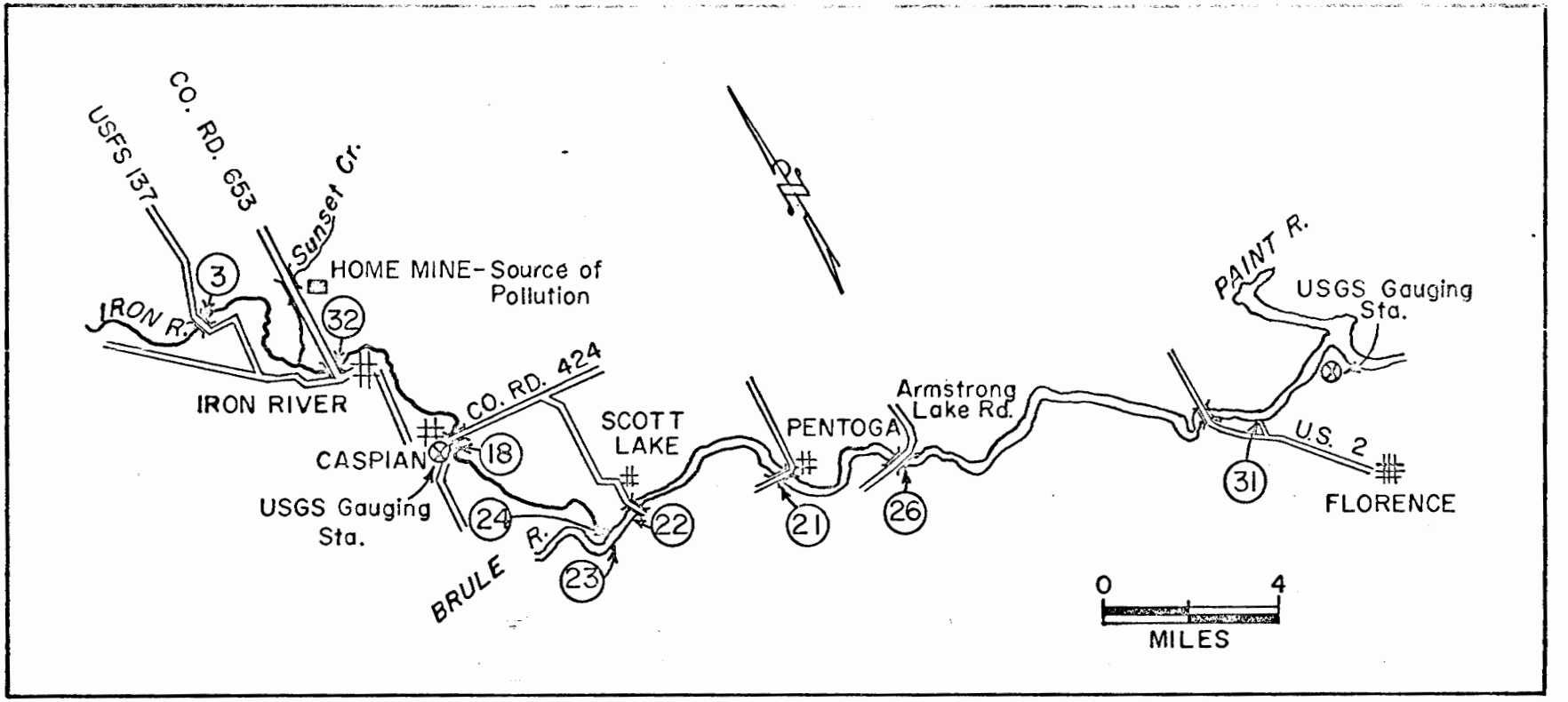

Fig. 1. --Sections of the Brule and Iron rivers in Iron County, showing locations of numbered stations where fish collections were made on September 21-23, 1964.

Table 1.--Data on fish collection stations, Brule and Iron rivers, Iron County, 1961-1964

Station number and year	River and location	Water conditions				Collecting effort (hour units)	Estimated shocking efficiency
		Color	Turbidity	Volume[1] (USGS)	Conductivity (C_{18} μmhos)		
No. 31	Brule						
1961	T. 41N, R. 32W,	Light brown	Murky	353	242	0.5	Fair
1962	Sec. 15	Muddy brown	Turbid	249	...[2]	0.6	Poor
1963		Smoky brown	Clear	190	333	0.6	Poor to fair
1964		Colorless	Very turbid	314	244	0.8	Poor
No. 26	Brule						
1961	T. 42N, R. 33W,	Light brown	Very turbid	353	250	1.2	Poor to fair
1963	Sec. 33	Smoky green	Clear	190	312	0.6	Good
1964		Colorless	Very turbid	314	246	0.7	Poor
No. 21	Brule						
1961	T. 42N, R. 34W,	Light brown	Muddy	377	242	0.8	Poor to fair
1962	Sec. 25	...	Muddy, turbid	242	...	0.7	Poor
1963		Smoky green	Clear	194	323	0.7	Fair
1964		Colorless	Turbid	305	254	0.7	Poor
No. 22	Brule						
1961	T. 42N, R. 34W,	Light brown	Murky, muddy	377	174 & 320[3]	1.0	Fair
1962	Sec. 21	...	Muddy, very turbid	249	...	0.8	Poor to fair
1963		Green brown	Turbid	194	254 & 395[3]	0.7	Fair
1964		Light brown	Turbid	305	197 & 320[3]	0.6	Poor
No. 23	Brule						
1961	T. 42N, R. 39W,	Dark brown	Clear	377	148	1.0	Poor to fair
1962	Sec. 29	Light brown	Clear	242	...	0.8	Fair
1963		Light brown	Clear	194	184	0.9	Fair to good
1964		Colorless	Clear	305	160	0.9	Fair

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Table 1.--concluded

Station number and year	River and location	Water conditions				Collecting effort (hour units)	Estimated shocking efficiency
		Color	Turbidity	Volume[1] (USGS)	Conductivity (C_{18} μmhos)		
No. 24	Iron						
1961	T. 42N, R. 34W,	Dark brown	Murky	61	500	0.7	Good
1962	Sec. 29	...	Muddy	55	...[2]	0.6	Fair
1963		Light brown	Turbid	39	577	0.8	Fair to good
1964		Light brown	Very turbid	54	450	0.8	Fair
No. 18	Iron						
1961	T. 42N, R. 35W,	Brown	Turbid	67	533	1.1	Poor
1962	Sec. 12	...	Muddy, turbid	55	...	0.6	Fair
1963		Brown	Slightly turbid	39	577	0.8	Fair to good
1964		Light brown	Very turbid	59	445	0.8	Fair to poor
No. 32	Iron						
1962	T. 43N, R. 35W,	Greenish brown	Turbid	62	...	0.4	Poor to fair
1963	Sec. 26	Smoky green	Clear	42	508	0.5	Good
1964		Light brown	Slightly turbid	59	390	0.5	Fair
No. 3	Iron						
1961	T. 43N, R. 35W,	Brown	Clear	67	160	1.0	Fair
1962	Sec. 17	Light brown	Clear	62	...	0.4	Good
1963		Light brown	Clear	42	205	0.4	Good
1964		Colorless	Clear	59	195	0.5	Fair to good

[1] For Brule River stations, determined from a gauging station near Florence. For Iron River stations, determined from a gauging station at Caspian.

[2] Data for collecting done in 1962 not available; samples met with an accident. New samples were collected on December 17, but at that time mine water was not entering Sunset Creek so the samples are of little significance.

[3] As the waters of the two streams were not completely mixed at this point, two samples were taken; the first value is for the south side (mostly Brule River water) and the second value is for the north side (mostly Iron River water).

was repeated on September 21-23, 1964. The same methods of fish collecting were employed at stations that had been sampled previously. However, two stations on the Brule River, Numbers 30 and 33, were omitted in 1964. The collecting conditions in 1964 approximated those encountered in October 1961 on the Brule and those encountered on the Iron River in 1962, whereas the collecting conditions in 1963 were very dissimilar. Hence the data of 1964 perhaps indicate the degree of recovery more reliably than those of 1963.

Although the water levels in September 1964 were high, it should be mentioned as a matter of record that mean monthly stream flow during the summer had been very low. Data published by the U.S.G.S. show that the mean flow in June and July was the lowest of all the years of this study. Changes in environmental conditions due to lower water levels--that is, greater warming of the water, slower movement, and greater frequency of small pools--may have accounted for some alteration in the fish fauna.

At the control station (No. 3) on the Iron River, the rate of catch by shocker increased from 429 fish per hour in 1963 to 760 fish in 1964 (Table 2). Blacknose and longnose dace and mottled sculpins were largely responsible for the increase. The collection contained 11 species, an increase of 5 over those collected in 1962 and 1963, and two more than were collected in 1961.

In the Iron River below the source of the acid mine-water pollution, the average catch per hour by shocker from the three stations combined increased from 256 fish in 1963 to 322 fish in 1964. The species chiefly

Table 2.--Catch per hour of fish, by species and station, Iron River, Iron County, 1961-1964

Species	Stations downstream from control station										
	24				18				32		
	1961	1962	1963	1964	1961	1962	1963	1964	1962	1963	1964
Brook trout	3	...	...	...	1	...	1	9	...	10	8
Brown trout	2	...	3	1	...	...	...	...	...	...	...
Rainbow trout	...	...	...	...	...	...	...	...	...	...	...
Mudminnow	2	...	...	4	3	...	...	4	...	...	2
White sucker	48	...	121	64	65	...	225	82	...	46	16
Longnose sucker	8	...	12	40	1	...	14	7	...	172	14
Creek chub	12	...	19	84	11	...	1	78	...	...	6
Pearl dace	...	...	...	...	...	...	...	...	...	4	...
Lake chub	15	...	...	...	10	...	2	3	...	...	...
Hornyhead chub	...	...	...	1	...	...	...	...	...	...	...
Blacknose dace	3	...	9	39	8	...	2	29	...	12	58
Longnose dace	...	...	...	...	...	...	...	...	...	24	36
Redbelly dace	...	...	...	...	...	...	...	1	...	...	...
Common shiner	17	...	3	130	15	...	...	3	...	...	2
Brassy minnow	...	...	...	...	...	...	...	...	...	...	...
Bluntnose minnow	...	...	1	...	...	...	...	...	...	...	...
Yellow perch	11	...	9	57	2	...	5	48	...	82	50
Walleye	2	...	...	...	...	...	...	...	...	...	...
Rock bass	...	...	1	...	...	...	...	...	...	2	...
Logperch	...	...	...	...	...	...	...	...	...	...	6
Mottled sculpin	...	...	7	5	...	...	...	3	...	18	44
Brook stickleback	...	...	...	4	1	...	...	...	...	...	...
Unidentifiable	...	...	...	...	...	...	...	...	...	...	...
Number of species	11	0	10	11	10	0	7	11	0	9	11
Total fish	80	0	139	323	129	0	209	201	0	185	121
Total catch per hour	121	0	185	430	119	0	252	267	0	370	242

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Table 2, --Concluded

Species	Average for stations 24, 18 and 32 from previous page				Control station (Station 3)			
	1961	1962	1963	1964	1961	1962	1963	1964
Brook trout	2	...	3	6	22	19	93	58
Brown trout	1	...	1	1	...	...	...	...
Rainbow trout	...	...	...	...	3	...	...	...
Mudminnow	2	...	...	4	2	...	...	4
White sucker	59	...	144	59	3	2	...	4
Longnose sucker	3	...	51	21	...	...	31	...
Creek chub	11	...	7	62	...	2	...	8
Pearl dace	...	...	1	...	1	...	5	6
Lake chub	12	...	1	1	...	...	...	...
Hornyhead chub	...	...	...	1	...	...	...	...
Blacknose dace	6	...	7	40	72	183	102	276
Longnose dace	...	...	6	9	37	24	81	160
Redbelly dace	...	...	...	1	...	...	...	...
Common shiner	16	...	1	50	...	...	...	...
Brassy minnow	...	...	...	...	...	...	...	2
Bluntnose minnow	...	...	tr	...	...	...	...	...
Yellow perch	5	...	25	52	...	...	...	...
Walleye	1	...	...	...	...	...	...	...
Rock bass	...	...	1	...	...	...	...	...
Logperch	...	...	...	2	...	...	...	...
Mottled sculpin	...	...	7	14	32	124	117	172
Brook stickleback	1	...	...	2	2	...	...	40
Unidentifiable	...	...	...	...	...	...	...	30
Number of species	12	0	14	16	9	6	6	11
Total fish	209	0	533	645	174	149	180	380
Total catch per hour	119	0	256	322	174	355	429	760

responsible for the higher rate of catch were the creek chub, blacknose dace, common shiner, and yellow perch. Sixteen species of fish were collected in this area in 1964, which was an increase of two over 1963 and four over 1961. Two species (bluntnose minnow and rock bass) taken in 1963, and one (walleye) taken in 1961, did not appear in the collections of 1964. Species which first appeared in 1964 were hornyhead chub, redbelly dace, and logperch. Differences in species composition are not considered very significant because the collecting was not intensive.

The catch per hour of 564 fish at the control station (No. 23) on the Brule River in 1964 represented a significant increase over the catches of preceding years (Table 3). The species most responsible for this increase was the blacknose dace. Species composition differed but little among years; 11 species were collected in 1964.

In the Brule River below the confluence of the Iron River, fish were caught at the average rate of 432 fish per hour in 1964, an increase of over 100% above the rate of 1962. Seventeen species were obtained in this section of the river in 1964, 19 in 1963, and 14 in 1962.

Evidence provided by the fish collecting done from 1961 through 1964 leads to these conclusions:

1. As no fish were obtained in December 1962 in the section of the Iron River polluted with acid mine water, and about 90% fewer fish were taken in the affected section of the Brule than in October 1961, it appears that the wastes exerted a highly deleterious effect on fish.

Table 3.--Catch per hour of fish, by species and station, Brule River, Iron County, 1961-1964

Species	Stations downstream from control zone										
	31				26			21			
	1961	1962	1963	1964	1961	1963	1964	1961	1962	1963	1964
Brook trout	4	2	7	7	...	...	...	...	3	...	4
Brown trout	...	...	2	...	...	...	...	...	...	...	3
Mudminnow	...	...	...	...	...	...	1	...	...	...	1
White sucker	...	5	29	1	9	62	22	18	14	240	86
Longnose sucker	2	...	21	4	1	40	7	1	5	88	43
Creek chub	18	26	26	102	50	26	229	92	2	248	103
Pearl dace	2	3	3	...	...	...	4	2	...	...	6
Lake chub	12	...	5	1	22	...	...	23	2	2	4
Hornyhead chub	...	...	...	...	...	...	...	...	...	...	...
Blacknose dace	106	2	10	16	112	55	54	122	...	127	249
Longnose dace	20	3	5	1	6	...	1	2	...	2	...
Redbelly dace	...	...	...	...	...	...	...	...	...	...	...
Common shiner	...	...	3	19	6	2	64	48	2	32	33
Brassy minnow	...	2	...	...	...	...	...	...	...	...	...
Bluntnose minnow	...	...	...	...	...	...	...	...	...	...	...
Smallmouth bass	2	...	...	...	...	...	...	...	...	...	...
Largemouth bass	...	...	...	...	...	...	...	...	...	...	...
Bluegill	...	...	...	...	...	...	...	...	...	...	...
Rock bass	...	...	...	...	...	...	...	...	...	2	...
Yellow perch	2	2	2	3	...	12	1	10	2	32	12
Black bullhead	...	...	...	...	...	...	1	...	...	...	...
Logperch	...	...	...	...	1	...	1	2	...	...	1
Mottled sculpin	10	2	...	5	11	5	1	10	6	6	22
Brook stickleback	...	...	3	...	1	3	4	1	...	2	9
Number of species	10	9	12	10	10	8	13	12	8	11	14
Total fish	89	27	68	120	273	119	264	275	22	515	388
Total catch per hour	178	46	117	160	218	205	394	331	33	769	579

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Table 3.--Concluded

Species	Stations downstream from control zone (concluded)								Control station (Station 23)			
	22				Totals for 31, 26, 21, 22							
	1961	1962	1963	1964	1961	1962	1963	1964	1961	1962	1963	1964
Brook trout	8	...	3	7	2	2	1	4	15	8	...	8
Brown trout	4	...	14	5	1	...	2	2	12	2	2	2
Mudminnow	...	...	...	...	...	...	...	tr	...	...	...	...
White sucker	27	9	121	62	13	7	88	40	8	31	23	9
Longnose sucker	...	3	11	3	1	5	29	14	...	...	37	5
Creek chub	59	5	27	98	62	14	86	131	28	23	50	41
Pearl dace	...	1	...	...	1	4	1	3	...	...	3	...
Lake chub	24	3	2	...	18	1	9	1	2	...	...	...
Hornyhead chub	...	...	...	2	1	tr	...	tr	...	...	...	...
Blacknose dace	50	3	127	423	93	3	66	171	146	118	165	338
Longnose dace	3	...	14	7	7	15	4	3	5	6	35	28
Redbelly dace	...	...	...	...	...	...	...	...	...	...	1	...
Common shiner	20	...	6	15	17	1	10	32	5	...	1	25
Brassy minnow	...	...	...	...	...	1	...	...	...	...	...	...
Bluntnose minnow	...	...	...	...	...	...	tr	...	...	...	1	3
Smallmouth bass	...	...	...	...	1	...	1	...	...	...	...	...
Largemouth bass	...	...	...	...	tr	...	tr	...	...	...	...	...
Bluegill	...	...	...	...	...	...	2	...	...	...	...	...
Rock bass	...	...	...	...	tr	tr	tr	...	...	...	...	...
Yellow perch	16	4	3	38	6	2	9	13	1	...	...	2
Black bullhead	...	...	...	...	...	...	...	tr	...	...	...	...
Logperch	1	...	...	...	1	...	1	tr	...	...	...	...
Mottled sculpin	4	3	56	32	13	12	28	15	21	55	75	99
Brook stickleback	1	...	...	...	1	...	2	3	...	...	...	...
Number of species	12	8	11	11	18	14	19	17	10	7	11	11
Total fish	217	23	253	415	854	72	955	1187	243	203	362	519
Total catch per hour	217	31	378	619	239	36	382	432	243	245	393	564

2. The large collections taken in September and October 1963 indicate that fish repopulated these areas rapidly after the pollution ceased. Presumably many of these fish had come from adjoining, unpolluted areas of the rivers and from tributaries.

3. Suspicion that especially favorable conditions for collecting may have unduly influenced the high rate of capture in 1963 was allayed by a still higher rate in 1964, when conditions for collecting were not so good as in 1963.

4. Appreciable increases in the fish catches of 1964 at control stations, as well as at stations in areas that had been polluted, indicate that some species (especially blacknose dace and creek chubs) were generally more abundant in the stream system this year than in 1961 and 1963.

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