Form 9-014

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON, D.C. 20242

EFFECTS OF ACID MINE DRAINAGE ON FISH AND MACROINVERTEBRATES OF THE TIOGA RIVER, PENNSYLVANIA AND NEW YORK

By

James L. Barker

U. S. GEOLOGICAL SURVEY OPEN-FILE REPORT

OFR 72-14

Prepared in cooperation with the
U.S. Army Corps of Engineers
Baltimore District

May 1972

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ABSTRACT

Acid water from abandoned coal mines in the vicinity of Morris Run and Blossburg, Pa., severely alter the aquatic environment of the Tioga River. From Morris Run to Crooked Creek, a reach of 19 miles, the river bed is influenced by a smothering blanket of heavy metal precipitates and highly acidic water. Biologically, this reach of the river is devoid of fishlife and nearly devoid of benthic macroinvertebrates. Downstream from Crooked Creek the water quality and biota are slowly restored. At Presho, N.Y., the river again supports an abundant and diversified population of fish and bottom-dwelling organisms.

INTRODUCTION

A chemical and biological reconnaissance of a 40-mile reach of the Tioga River, from its headwaters in Pennsylvania to Presho, N.Y., was made during July 1970. The study was undertaken by the U.S. Geological Survey at the request of the U.S. Army Corps of Engineers, Baltimore District. The purpose was to measure the effects of acid mine drainage on the aquatic life in the Tioga River.

The study consisted of a cursory documentation of the fish and benthic macroinvertebrates inhabiting six selected reaches of the river above and below tributaries that discharge acid water. Samples of fish were collected with electrofishing gear and benthic organisms were collected with the aid of a fine-mesh dip net. The water chemistry phase of the study consisted of streamside measurements of pH and specific conductance at 19 sampling sites.

Acknowledgments

This investigation was conducted with the assistance of the Pennsylvania Fish Commission and the New York Conservation Department, Division of Fish and Game, which supplied fish population data for the New York section of the Tioga River.

FINDINGS

Sampling sites for fish and macroinvertebrates were selected to be representative of the reach under investigation. The pH and specific conductance values are illustrated in figure 1 and the distribution and numbers of families of benthic macroinvertebrates and species of fish in the study area are shown in figure 2. Stream mileage figures were computed from stream-mile 0.0 at the confluence of the Canisteo and Tioga Rivers. As a supplement to the data in figures 1 and 2, a description of the physical, chemical, and biological observations made on each of the six study reaches of the Tioga River is included.

Tables 1 and 2 are compilations of the biological data. They present the relative abundance of each species of fish collected from several stations on the Tioga River and one station on its tributary, Mill Creek, as well as the percentage of the macroinvertebrate population represented by the identified families.

When this biological survey was conducted,. the discharge of the Tioga River at Tioga, Pa., was approximately half the corresponding flows observed in the previous 19 years. In contrast, the flow of Crooked Creek was nearly the same as the average of the flows observed in the same period during the previous 17 years. The discharge-pH relation for these two streams is not completely known, but the pH of the Tioga River at Tioga Junction is known to vary from 4.6 to 7.8, depending upon discharge of the two streams (U.S. Geol. Survey, unpublished data, station no. 01-5181). It was further noted that both the lowest and highest observed pH values occurred at low flow (less than 80 cfs (cubic feet per second)).

Station Location

Station T-1	Stream mile 40.7, 0.5 mile downstream of County bridge.
Station T-1A	Stream mile 35.5, 0.7 mile upstream of confluence with Morris Run.
Station T-2	Stream mile 33.6, 0.1 mile upstream from Bear Creek.
Station T-3	Stream mile 24.7, at Route 6 bridge, Mansfield, Pa.
Station M-1	Sample collected at point 2.5 miles upstream from mouth of Mill Creek.
Station T-4	Stream mile 16.5, 0.1 mile downstream of Tioga, Pa. gage
Station T-5	Stream mile 11.8, 0.1 mile downstream of bridge at Tioga Junction.
Station T-6	Stream mile 2.0, 0.4 mile downstream of mouth of Glendening Creek.

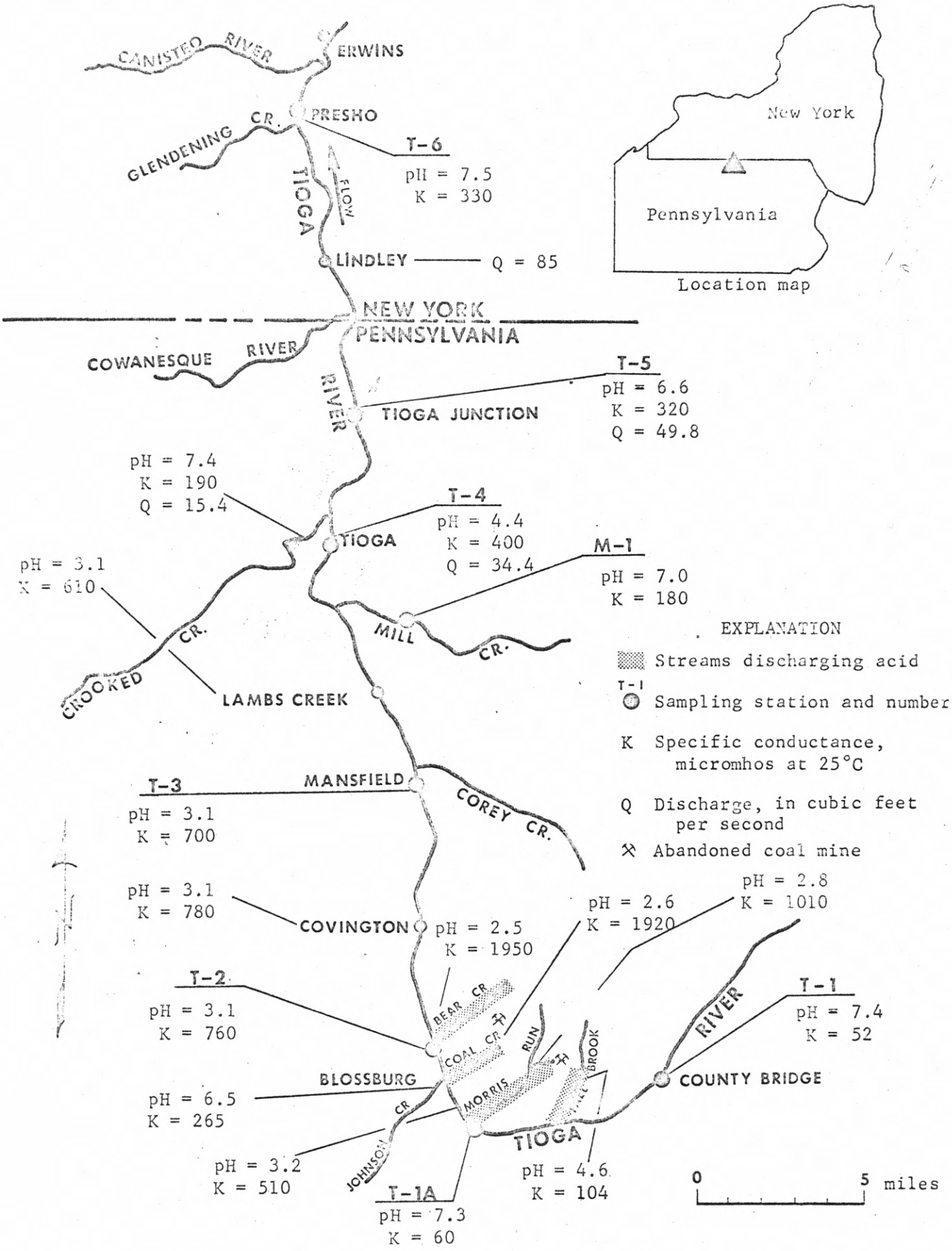

Figure 1.--Specific conductance and pH of streams in the Tioga River study area, July 9, 1970.

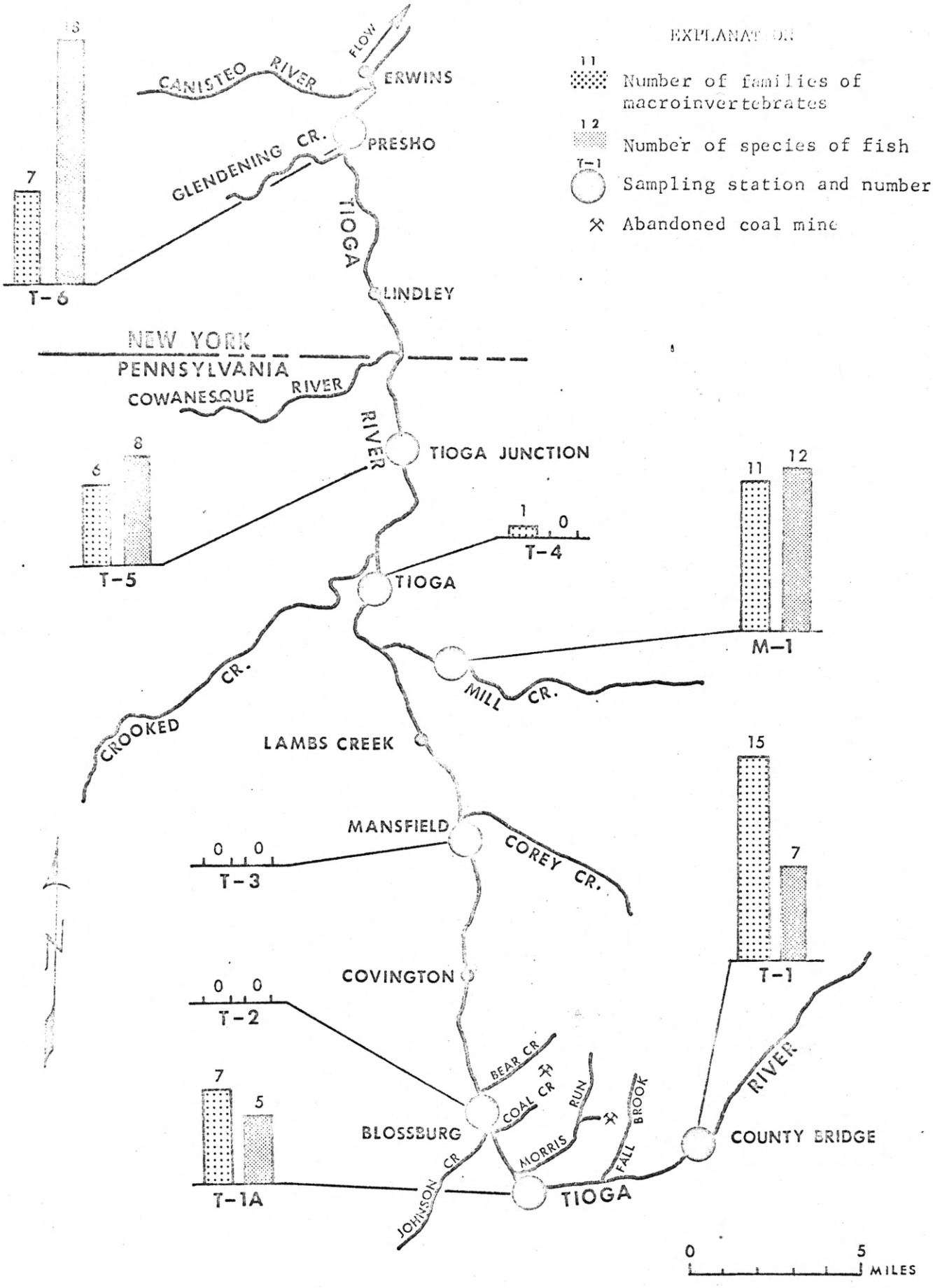

Figure 2.--Numbers of families of benthic macroinvertebrates and species of fish in the Tioga River study area, July 21-22, 1970.

Headwaters to the confluence with Morris Run (mile 34.9)

This 12-mile reach of the Tioga River is characterized by relatively good water quality as evidenced by intermediate pH and low specific conductance values. The river section supports an important trout fishery with native and stocked brook trout the predominant predatory species. At the County Bridge station, the brook trout and six other species of fish were collected (fig. 2). Representatives of 15 macroinvertebrate families, including the so-called clean-water forms of mayflies, stoneflies, and caddis flies, were collected at this station.

Fewer fish and macroinvertebrates were found in the lower end of this reach, just above Morris Run, than were found at County Bridge station. The observed differences in the faunal population at the two stations might have resulted from recent scouring of the lower end of the reach by high streamflow.

Morris Run (mile 34.9) to Bear Creek (mile 33.6)

This 1.3-mile reach of the Tioga River displays the full effects of mine drainage that discharges into Morris Run, Coal Creek, and Bear Creek tributaries. The severe environmental damage is attributed to mineral acids, the ions of iron and sulfate, and the smothering blanket of a yellow to reddish-brown precipitate of ferric hydroxide, called "yellow-boy." Coal fines were observed to have discharged from Johnson Creek and coated the river bottom with a black sediment for a short distance below the mouth of this creek. Fish and benthic macroinvertebrates were not found in this reach.

Bear Creek (mile 33.6) to Corey Creek (mile 24.6)

The 9.0-mile reach of the Tioga River from Bear Creek to Corey Creek also showed the adverse effects of mine drainage. At Mansfield and at Covington, the pH was 3.1. The "yellow-boy" becomes less noticeable toward the lower end of the reach. At Covington, Pa., filamentous algae were observed on the rocky bottom. At Mansfield, Pa., growths of filamentous algae and rooted aquatic vegetation were observed. Fish and benthic macroinvertebrates were absent in this reach.

Corey Creek (mile 24.6) to Crooked Creek (mile 16.1)

In this 8.5-mile reach the river continued to display effects of mine drainage, but some notable improvements in chemical quality were evident. The "yellow-boy" was considerably less abundant than in the upstream reach. At stream mile 19.3 water from Mill Creek with a neutral pH mixes with the Tioga River. Where this mixing occurs, ferric hydroxide is replaced by a precipitate of gray aluminum hydroxide. Water from Mill Creek was responsible for the pH of the river increasing from 3.1 at Lambs Creek to 4.4 at the town of Tioga, Pa. Biological and chemical data show Mill Creek to be a high quality stream containing a good population of clean-water forms.

Algae and rooted vegetation were prevalent in much of the shallow water in this reach. A benthos sample, collected at Tioga, Pa. (mile 16.6), contained a single diptera larvae belonging to the family Ceratopogonidae or biting midges. Fish were not present in this reach.

Crooked Creek (mile 16.1) to Cowanesque River (mile 8.7)

This reach of 7.4 miles was a zone of intermittent recovery. The streambed was colored gray by precipitated aluminum hydroxide. The neutralizing effects of the alkaline waters of Crooked Creek caused the Tioga River to take on a new appearance and to support aquatic life. Algae and rooted aquatic vegetation were present, but fish and macroinvertebrates were not abundant. At Tioga Junction, Pa. (mile 11.9), the pH was 6.6. A fish sample collected here contained eight species that included smallmouth bass, walleye, and several minnows. Although most of the sample consisted of juvenile fish, adult smallmouth bass and white suckers were observed in the deeper waters. The samples of benthic macroinvertebrates indicated a partial recovery in the water quality of the reach as six families--including stoneflies and caddis flies--were collected. As noted previously, the pH of this reach is known to range from 4.6 to 7.8, depending upon the flow of Crooked Creek and the acidity of the Tioga River. The fluctuating pH probably limits the population of organisms to a few tolerant types.

Cowanesque River (mile 8.7) to confluence with Canisteo River (mile 0.0)

The Tioga River continued to recover in this 8.7-mile reach. The streambed had a blue-gray tinge because of a trace of aluminum hydroxide precipitate. The pH was 7.5 on July 9, 1970. Toward the lower terminus of this reach, at Presho, N.Y. (mile 2.0), the river had nearly recovered from the effects of the mine drainage. The resident fish population at this point contained a warm-water group of 18 species. Benthic macroinvertebrates were numerous and represented seven families, including the clean-water forms such as mayflies, caddis flies, dobson flies, and riffle beetles.

Table 1.--Distribution and number of fish observed in the Tioga River and Mill Creek sample areas, July 1970

Species		Station (stream mile)							
		T-1	T-1A	T-2	T-3	M-1	T-4	T-5	T-6
		(40.7)	(35.5)	(33.6)	(24.7)	T(19.3) M(2.5)	(16.5)	(11.8)	(2.0)
Common name	Scientific name	Area sampled, acres							
		0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.5
Brown trout	Salmo trutta	3	1	No fish in sample	No fish in sample		No fish in sample		
Brook trout	Salvelinus fontinalis	25	4						
White sucker	Catostomus commersoni	9	1			100+		80+	75+
Common shiner	Notropis cornutus					100+			
Creek chub	Semotilus atromaculatus	2				6			1
Blacknose dace	Rhinichthys atratulus	129	4			59+			
Longnose dace	Rhinichthys cataractae	17	1			47+			
Cutlips minnow	Exoglossum maxillingua					39			
Northern hog sucker	Hypentelium nigricans					28			5+
Mottled sculpin	Cottus bairdi	3				5			1
Stoneroller	Campostoma anomalum					75+		75+	20+
Margined madtom	Noturus insignis					12		10	
River chub	Hybopsis micropogon					31			1
Spottail shiner	Notropis hudsonius							35	45+
Smallmouth bass	Micropterus dolomieui							1	6

Table 1.--Distribution and number of fish observed in the Tioga River and Mill Creek sample areas, July 1970--Con'

Species		Station (stream mile)							
		T-1	T-1A	T-2	T-3	M-1	T-4	T-5	T-6
Common name	Scientific name	(40.7)	(35.5)	(33.6)	(24.7)	T(19.3) M(2.5)	(16.5)	(11.8)	(2.0)
		Area sampled, acres							
		0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.5
Pumpkinseed	Lepomis gibbosus							2	1
Walleye	Stizostedion vitreum vitreum							1	
Johnny darter	Ethoestoma nigrum							6	5±
Fathead minnow	Pimephales promelas					1			
Chain pickerel	Esox niger								2
Yellow perch	Perca flavescens								2
Rock bass	Ambloplites rupestris								5±
Carp	Cyprinus carpio								25±
Fallfish	Semotilus corporalis								1
Bluntnose minnow	Pimephales notatus								15±
Blacknose shiner	Notropis heteroplepis								10±
Shield darter	Percina peltata								1

Table 2.--Distribution and population composition of families of benthic macroinvertebrates in the Tioga River and Mill Creek, July 1970

Common name	Order	Family	Station (stream mile) T-1 (40.7)	T-1A (35.5)	T-2 (33.6)	T-3 (24.7)	M-1 T (19.3) M(2.5)	T-4 (16.5)	T-5 (11.8)	T-6 (2.0)
			Percent of population							
Stoneflies	Plecoptera	Perlidae	5		No macroinvertebrates in sample	No macroinvertebrates in sample	2		6	
		Pteronarcidae	1							
		Nemouridae	15	2						
		Peltoperlidae		2						
Mayflies	Ephemeroptera	Baetidae	20	24			42			5
		Heptageniidae	15	8			2			
Caddis flies	Trichoptera	Hydropsychidae	28	45			46		25	12
		Hydroptilidae	1							
		Rhyacophilidae	1							
		Philopotamidae	1	17			.5			65
		Helicopsychidae					2			
True flies	Diptera	Rhagionidae					.5		13	2
		Tendipedidae	2				2		25	
		Tipulidae	3							
		Simuliidae		2						
		Ceratopogonidae						100		
		unidentified					1			
Fish fly or Dobson fly	Megaloptera	Corydalidae	4							2
Alder fly	Megaloptera	Sialidae							6	

Table 2.--Distribution and population composition of families of benthic macroinvertebrates in the Tioga River and Mill Creek, July 1970--Continued

Common name	Order	Family	Station (stream mile) T-1 (40.7)	T-1A (35.5)	T-2 (33.6)	T-3 (24.7)	M-1 T(19.3) M(2.5)	T-4 (16.5)	T-5 (11.8)	T-6 (2.0)
			Percent of population							
Water bugs	Hemiptera	Veliidae	2							
Beetles	Coleoptera	Gyrinidae							25	7
		Elmidae	1				1			
		Psephenidae					1			
Crayfish	Decapoda	Astacidae	1							
Snails	Gastropoda	Physidae								7
		Total number of kinds	15	7	0	0	11	1	6	7

SUMMARY AND CONCLUSIONS

From its headwaters to its confluence with Morris Run, the Tioga River is a good quality mountain stream that supports a significant trout fishery. Acid water from abandoned deep and strip mines discharges into Morris Run, Coal Creek, and Bear Creek, which, in turn, enter the Tioga River. The acid water alters the physical, chemical, and biological aspects of the river.

From Morris Run downstream 19 miles to Crooked Creek, the riverbed was coated with a smothering blanket of ferric and aluminum hydroxide precipitate. Downstream from Morris Run the river changed from a slightly alkaline water of low dissolved-solids content to highly acidic water having a relatively high dissolved-solids content. Biologically, this 19-mile reach of the Tioga River was nearly sterile. The river was devoid of fish and nearly devoid of bottom-dwelling organisms.

The influence of alkaline water from Corey Creek, Mill Creek, and other lesser tributaries is insufficient to neutralize or adequately dilute the acid water of the main river enough to permit biological restoration. Crooked Creek, entering the Tioga River at stream-mile 16.1, causes an intermittent, partial, restoration of water quality.

Downstream from Crooked Creek, fish and bottom-dwelling organisms were reestablished as the pH approached neutrality. The Cowanesque River and several smaller tributaries helped restore the quality of the Tioga River to the point where it supported a valuable gamefish population of smallmouth bass. Also, below the mouth of the Cowanesque, benthic macroinvertebrates were restored to an abundant and diversified population of clean-water forms.

Changes in pH will have a harmful effect upon the biota of the Tioga River, if the change is sudden, or if the tolerance limits of the organisms are exceeded. The sparse macroinvertebrate population and predominance of juvenile fish captured at Tioga Junction may indicate that low pH or other toxic conditions occur periodically, and that a fish migration into the reach follows the temporary improvement in water quality.

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