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STATUS OF FAUNAL RECOVERY IN THE NORTH FORK HOLSTON RIVER, TENNESSEE AND VIRGINIA

by

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ABSTRACT

Two years after pollution abatement, faunal communities in the North Fork Holston River below Saltville, Virginia, remain in a perturbed condition. The number of fish species is increasing at the lower downstream stations, but show little change immediately downstream of Saltville. Two species which occur regularly above Saltville were not taken at any downstream station during this study.

The abundance and diversity of aquatic insects at downstream stations are extremely variable, but are generally less below Saltville than they are upstream. Populations of mussels have not been successful in recolonizing downstream areas.

Water quality parameters fall within acceptable ranges for healthy aquatic communities, but an analysis of river sediments documents the existence of high mercury concentrations.

The relatively slow rate of natural recovery processes can probably be attributed to the continuing input of toxic materials from the abandoned waste lagoons.

INTRODUCTION

For decades increasing numbers of streams throughout the United States and other countries have been subject to municipal, agricultural, and industrial waste discharges. The degree of damage suffered varies according to a complex of interrelated factors which include the characteristics of the receiving stream and the nature, magnitude, and frequency of the stress or stresses applied. Often the degradation has been so severe and of such long duration that the streams are no longer considered valuable in terms of their biological resources.

With the advent of the current environmental movement, significant numbers of streams are experiencing pollution abatement, and, consequently, have the potential for biological recovery. Cairns, Crossman, Dickson, and Herricks (1971) concluded that the biological recovery of damaged streams is a function of the physical, chemical, and biological characteristics of the receiving stream, the severity and duration of the stress, and the availability of undamaged areas to serve as sources for recolonizing organisms. If the restoration of damaged streams is to be considered a viable alternative in the management of stream fishery resources, something must be known of the rate and sequence of natural recovery processes.

The North Fork Holston River below Saltville, Virginia, has been subject to the stress of a variety of inorganic pollutants discharged from a chemical plant over several decades. In July 1972 the Saltville plant ceased operation because it was not economically feasible to comply with standards established by the Virginia State Water Control Board. This report represents an assessment of faunal recovery in the North Fork Holston River to date. It will form the basis for management efforts aimed at the restoration and rejuvenation of more than eighty miles of this stream (Figure 1).

STUDY AREA AND METHODS

The North Fork Holston River originates in Smyth County, Virginia, and flows southwest about 135 miles to its junction with the South Fork Holston River about five miles south of the Virginia-Tennessee state line in the vicinity of Kingsport, Tennessee. A medium-hardwater stream, the North Fork has a high riffle-pool ratio and a substrate consisting mainly of sand, gravel, and rubble, with boulders predominating in many of the shoal areas. The average annual discharge of the North Fork at Saltville for the period 1921-1957 was 289 cubic feet per second (Ross, 1963). Average minimum flow for the same period was 29 cubic feet per second. Flows in the lower portion of the river near its mouth are about three times the flow at Saltville.

The chemical plant is located on the banks of the North Fork at River Mile 80.3. Engaged in the production of sodium hydroxide, sodium carbonate, sodium bicarbonate, hydrazine, chlorine, and dry ice since 1894, the plant was discharging over extended periods of time approximately 950 tons per day of calcium chloride and 575 tons per day of sodium chloride (Anonymous, 1968). Additional wastes consisting of sand, unreacted limestone particles, and small amounts of mercury from electrolytic cells were discharged in lesser amounts after being routed through settling lagoons. Those abandoned lagoons now form a refuse heap of more than 300 surface acres with outer banks more than 50 feet high in places, and bordering the river for approximately 2.6 miles. Even though the plant ceased operation in 1972, the abandoned settling lagoons are subject to erosion and seepage of dissolved and particulate inorganics into the river.

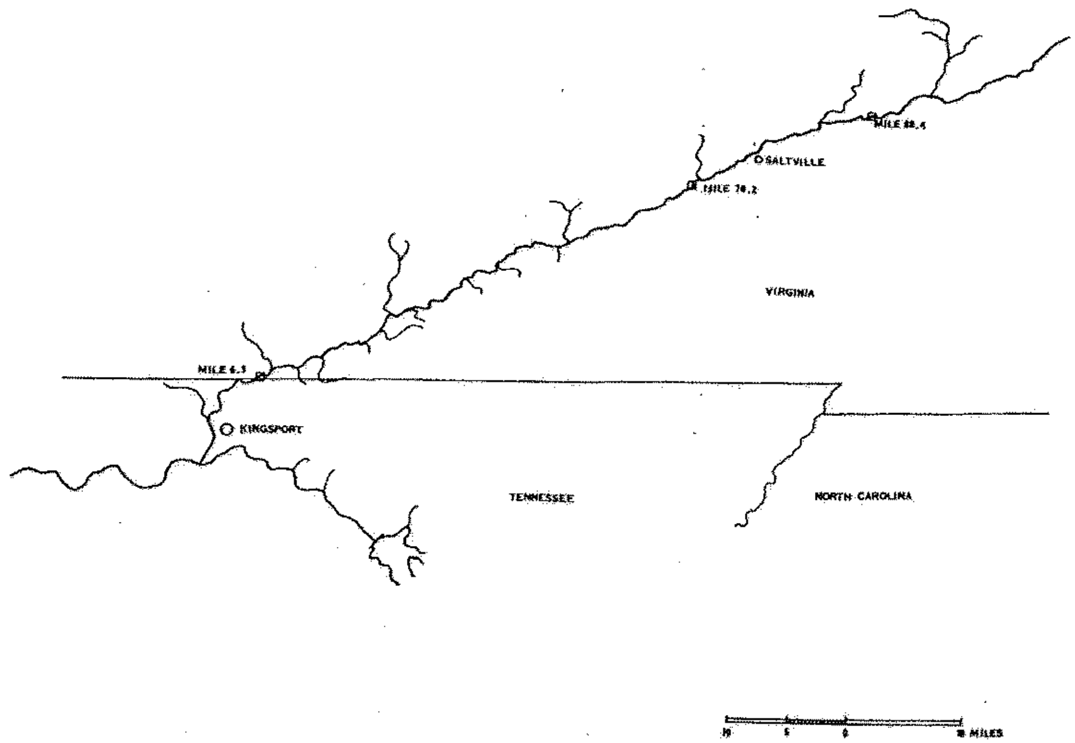

Figure 1. Map of North Fork of the Holston River showing one sampling site above and two below Saltville, Virginia.

Figure 1. Map of North Fork of the Holston River showing one sampling site above and two below Saltville, Virginia.

In anticipation of pollution abatement at Saltville, periodic fish and bottom fauna collections were initiated concurrently with sampling of fishes for mercury analysis in the fall of 1970. One area above and two below Saltville (Figure 1) were sampled quarterly in acquiring fish for mercury analysis and in assessing fish and invertebrate standing crops, distribution, and taxonomic composition relative to the plant at Saltville. Samples above Saltville were taken from River Mile 83 to 88.6 and those below Saltville were taken between River Miles 70 and 79, and River Miles 0.2 to 8.8, respectively. In August 1973 additional fish and bottom fauna sampling stations were established at approximately 10-mile intervals from Saltville to the river's mouth specifically to evaluate the success of natural recovery processes and stream restoration efforts to be undertaken.

Fish

All fish collections were made using either rotenone or cyanide. Sample areas consisted of riffle and pool sections and ranged in size from 0.54 to 1.2 acres. During the collections, 3/8-inch block nets were stretched across the lower end of the stations and rotenone or cyanide was applied in the riffle area at the upper end. Dead and dying fish were collected with dip nets, preserved in 10 percent formalin in the field and were sorted and identified in the laboratory.

Bottom Fauna

All bottom fauna samples were taken in shoal areas with an unmodified Surber square foot sampler. At least four samples in transect were taken at each station during each sampling period. The samples were preserved in the field in 10 percent formalin and were sorted and identified in the laboratory.

Mussels

Estimates of the distribution and relative abundance of mussel species are based upon collections made by qualitative sampling by hand and with a Needham Scraper. Specimens collected were kept in moist cloth sacks and relaxed and preserved in the laboratory.

Water Quality

All water quality measurements reported herein were made by personnel of TVA's Water Quality Branch. Temperature, dissolved oxygen, pH, specific conductance and alkalinity were measured in the field with a Model 70 *Hydrolab instrument*. Total hardness and chlorides were determined titrametrically in the laboratory. All heavy metal concentrations were measured by atomic absorption spectrophotometry.

Diversity Indices

d is a measure of community structure based on information theory as reported by Wilhm and Dorris (1968) according to the formula d =   Ni/N)log2(Ni/N) where Ni is the number of individuals in ith taxon and N is the total number of organisms in the sample.

RESULTS AND DISCUSSION

Water Quality

Water quality measurements above and below Saltville during the periods 1967 to 1968 and 1973 to 1974 (Table 1) show a dramatic improvement in the North Fork Holston River downstream of the closed chemical plant. Parameters most changed are total hardness and specific conductance and concentrations of calcium, sodium, and chloride ions. Although improved, all of these parameters remain higher than at upstream stations. Mercury concentrations are higher in river water just downstream of Saltville (mean 3.7 ug/l) than they are upstream (mean 0.28 ug/l), but are not significantly different than near the river's mouth. Mercury concentrations in river sediments (Figure 2) show a similar longitudinal decrease downstream from Saltville. The persistently high concentrations of mercury in river sediments at River Mile 79.8 (immediately below the waste lagoons) and the occasional peaks at stations further downstream together with the higher downstream concentrations of certain other ions is strong evidence of the continuing input of significant quantities of toxic materials from the abandoned waste lagoons.

Bottom Fauna

Community structure analyses as represented by diversity indices (Figure 4) reflect a perturbed and ever-changing community of benthic macroinvertebrates downstream of Saltville. Characteristic of "healthy" communities, the diversity indices for organisms sampled above Saltville are consistently three or greater while comparable collections below Saltville seldom approach this level of diversity. The seemingly random variation in diversity both in terms of community structure (Figure 3), and simply the number of taxons per collection at downstream stations (Figure 4), suggests continued colonization, but unsuccessful establishment of viable populations of macrobenthos. Again, the failure of this river to purge itself and undergo natural recovery processes can probably be attributed to the continued input of toxic materials from the abandoned waste lagoons.

Table 1. A summary of water quality data collected from the North Fork Holston River at one area above and two areas below Saltville, Virginia.

Dates	Statistics	D.O. Mg/l	pH	Cl- Mg/l	Ca++ Mg/l	Mg++ Mg/l	Na+ Mg/l
				River Mile 88.6			
6-5-67	Mean	9.62	8.22	7.87	23.51	9.27	3.74
to	Range	7.3-12.9	8,0-8.6	0-33	14.0-29.0	6.0-14.6	1.209.2
4-8-68	Std. deviation	1.63	0.17	11.14	5.89	5.02	3.12
	No. of Observ.	8	8	8	8	8	7
1-23-73	Mean	12.6	8.0	4.0	27.0	8.8	1.2
to	Range	-	-	-	-	-	-
2-13-74	Std. deviation	0	0	0	0	0	0
	No. of Observ.	1	1	1	1	1	1
				River Mile 59.4			
6-5-67	Mean	9.61	7.86	1,306	635	10.2	462
to	Range	6.8-11.6	7.2-8.3	318-2,350	114-1,265	6.0-13.9	79-780
4-8-68	Std. deviation	1.8	0.35	914	450	2.78	227
	No. of Observ.	8	8	8	8	8	7
				River Mile 70			
1-23-73	Mean	12.5	8.3	66	44	6.8	26
to	Range	-	-	-	-	-	-
2-13-74	Std. deviation	0	0	0	0	0	0
	No. of Observ.	1	1	1	1	1	1
				River Mile 0.2			
6-8-67	Mean	10.09	7.51	964	364	15.1	213
to	Range	6.2-12.2	6.1-8.4	190-3,250	74-612	7.5-38.5	4.1-584
4-9-68	Std. deviation	1.92	0.76	1,003	264	8.6	194
	No. of Observ.	10	10	10	10	10	10
				River Mile 8.8			
6-27-72	Mean	9.53	7.87	78	51.4	8.8	33.2
to	Range	6.2-12.4	7.3-8.4	23-120	37-90	6.5-13.0	8.9-58
2-12-74	Std. deviation	1.87	0.55	64.6	18.8	2.2	19.2
	No. of Observ.	8	8	6	8	8	6

Table 1. A summary of water quality data collected from the North Fork Holston River at one area above and two areas below Saltville, Virginia (continued).

Dates	Statistics	Total Alkalinity Mg/l	Total Hardness Mg/l	Specific Conductance Microhms	Hg++ ug/l	Cu++ ug/l	Cd++ ug/l
				River Mile 88.6			
6-5-67	Mean	90	102	268	-	-	-
to	Range	53-122	62-127	140-385	-	-	-
4-8-68	Std. deviation	28.58	28.72	101	-	-	-
	No. Observ.	8	8	8	-	-	-
1-23-73	Mean	88	100	190	0.28	12.0	1
to	Range	-	-	-	0.2-0.5	10-20	-
2-13-74	Std. deviation	0	0	0	0.13	4.47	0
	No. Observ.	1	1	1	5	5	5
				River Mile 59.4			
6-5-67	Mean	64.6	1,627	4,832	-	-	-
to	Range	56.75	320-3,207	1,337-8,467	-	-	-
4-8-68	Std. deviation	6.7	1,135	3,160	-	-	-
	No. Observ.	8	8	7	-	-	-
				River Mile 70			
1-23-73	Mean	75	140	420	3.72	16.0	1.2
to	Range	-	-	-	0.2-17.0	10-30	1-2
2-13-74	Std. deviation	0	0	0	7.42	8.9	.44
	No. of Observ.	1	1	1	5	5	5
				River Mile 0.2			
6-8-67	Mean	71	1,044	3,433	-	-	-
to	Range	45-87	220-2,028	983-7,757	-	-	-
4-9-68	Std. deviation	14.7	640	2,370	-	-	-
	No. of Observ.	9	10	9	-	-	-
				River Mile 8.8			
6-27-72	Mean	91	165	438.6	0.30	16.0	2.00
to	Range	78-100	120-280	280-540	0.2-0.5	10-20	1-6
2-12-74	Std. deviation	8.7	56.1	159.2	0.14	5.47	2.23
	No. of Observ.	5	8	7	5	5	5

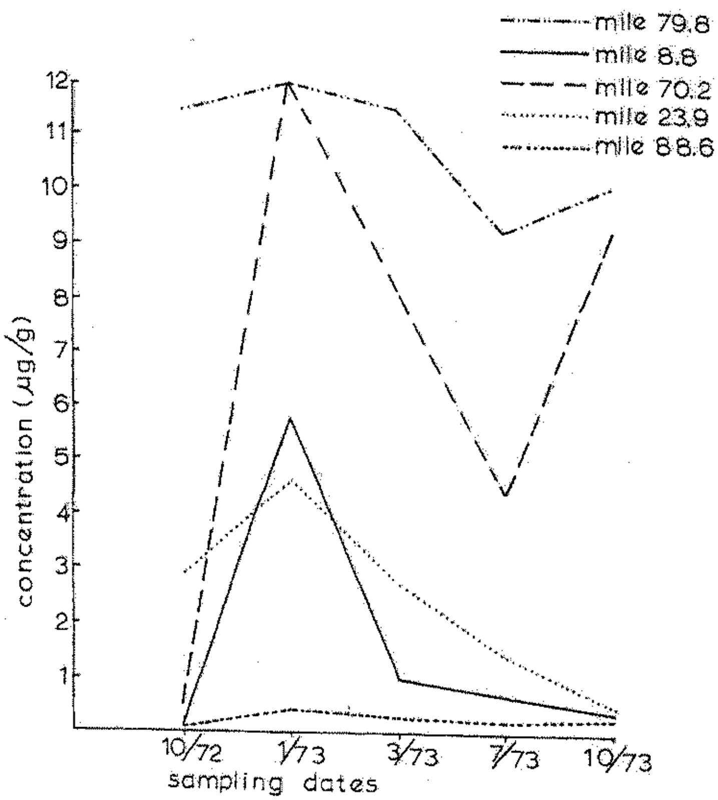

Figure 2. Concentration of mercury in river sediments above (RM 88.6) and below Saltville, Virginia.

Insepction of the taxonomic composition of bottom fauna communities above and below Saltville (Table 2) provides additional insight into their natural recovery processes. The mayflies (ephemeroptera) are conspicuously less dominant in the benthic community downstream of Saltville than they are upstream, although there appears to be a trend toward increasing dominance at the downstream stations with time. Of particular interest is the fact that members of the family Ephemeridae (burrowers) are virtually nonexistent at the downstream stations, possibly reflecting toxic concentrations of mercury or other substances in the river sediments.

Megalopterans, trichopterans, lepidopterans, and dipterans appear to have been relatively unaffected by plant discharges and the persistent influx of materials from the waste lagoons.

Elmid beetles are successfully established members of the benthic community both upstream and downstream of Saltville, but members of the family psephenidae have not yet become established downstream of Saltville.

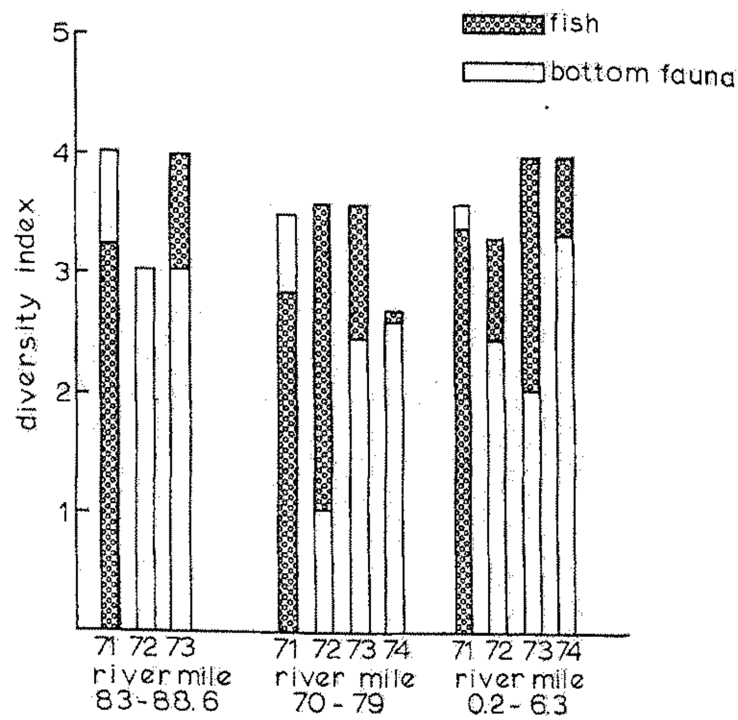

Figure 3. Diversity values for fish and bottom fauna at three stations, 1971-1974.

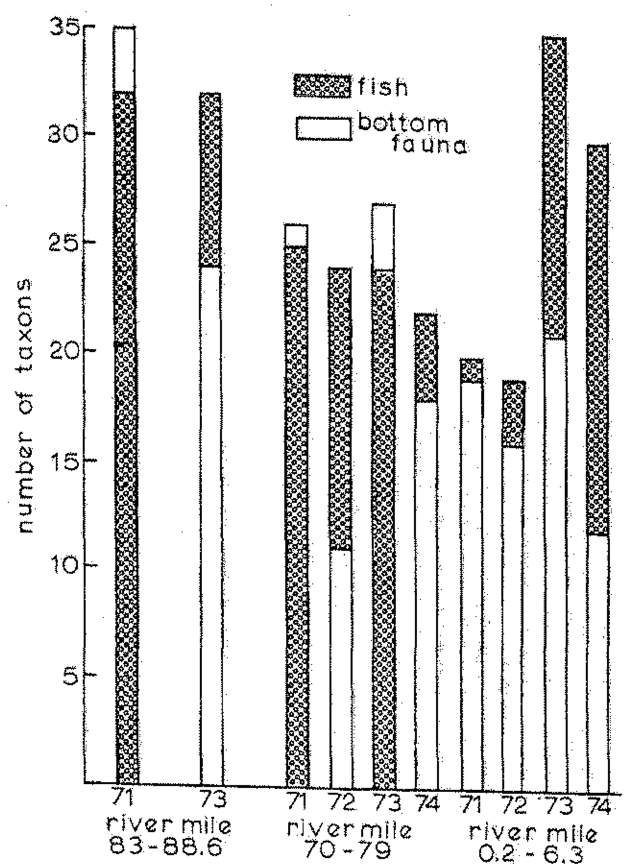

Figure 4. Number of taxons of fish and bottom fauna at three stations, 1971-1974.

Table 2. Percentage composition (by family) of macroinvertebrates.

Family	River Mile 83.3 6-30 1971	8-11 1972	7-11 1973	5-24 1974	6-28 1971	River Mile 79 6-15 1972	7-11 1973	5-24 1974	6-28 1971	River Mile 0.2 6-16 1972	7-9 1973	5-24 1974
Platyhelminthes												
Turbellaria												
Tricladida												
Planariidae	0.7	-	-	-	-	-	-	-	-	-	-	-
Nematoda	-	-	-	-	-	-	Tr	-	-	-	-	-
Annelida	-	-	-	-	-	-	0.2	-	-	-	-	-
Oligochaeta	1.7	-	0.8	0.4	2.8	2.0	-	0.3	0.8	-	0.3	14.3
Arthropoda	-	-	-	-	-	-	0.1	-	-	-	-	-
Crustacea												
Isopoda												
Asellidae	1.0	-	-	-	-	-	-	-	-	-	-	-
Decapoda	-	-	1.2	-	0.3	-	-	-	-	0.6	0.3	4.8
Arachnoidea												
Hydracarina	-	-	-	-	-	-	0.7	-	-	-	-	-
Insecta												
Collemba												
Plecoptera												
Nemouridae	-	-	0.2	2.1	-	-	-	0.6	-	-	-	9.5
Perlidae	0.7	2.5	1.0	1.3	-	0.8	-	0.3	-	-	0.3	-
Perlodidae												
Chloroperlidae												
Ephemgroptera												
Baetidae	26.2	5.0	20.3	17.2	0.8	-	22.2	5.076.3	-	3.1	9.5	
Heptageniidae	11.1	37.5	20.7	42.4	-	0.4	0.1	6.0	-	1.5	10.4	9.5
Ephemeridae	2.1	2.5	3.5	0.4	-	-	-	-	-	-	-	9.5
Odonata												
Coenagrionidae	0.3	-	-	-	0.3	-	Tr	-	-	-	-	-
Cordulegasteridae	-	-	-	-	0.8	-	-	-	-	-	0.8	9.5
Gomphidae												
Hemiptera												
Vellidae	-	-	0.2	-	-	-	Tr	-	-	-	-	-
Megaloptera												
Corydalidae	-	-	-	-	1.3	-	0.2	0.6	3.0	-	-	-
Sialidae	0.2	-	-	0.4	-	-	Tr	-	0.8	-	-	-

Trichoptera												
Hydropsychidae	5.0	7.5	29.2	3.8	29.8	1.2	32.8	57.1	35.7	14.6	17.7	-
Brachycentridae	-	-	-	-	1.5	-	-	-	-	-	2.1	-
Hydroptilidae	1.2	-	-	-	7.5	-	-	-	4.3	0.3	0.3	-
Helicopsychidae	-	-	-	-	-	-	0.8	-	-	-	-	-
Philopotamidae	-	2.5	-	-	2.3	-	-	-	6.0	-	-	-
Psychomyiidae	-	-	-	-	-	-	Tr	-	-	-	-	-
Leptoceridae	-	-	-	-	-	-	-	-	-	0.3	-	-
Limnephilidae												
Molannidae	-	-	-	-	-	-	-	-	-	26.9	-	-
Goeridae	4.6	-	-	-	-	-	-	-	-	0.3	-	-
Lepidoptera												
Pyralididae	-	-	-	-	23.8	-	0.2	-	11.5	-	1.0	-
Diptera												
Tendipedidae	8.3	-	1.8	17.6	18.1	5.7	-	21.6	16.2	6.3	4.9	28.6
Tipulidae	5.0	-	0.8	-	0.3	4.1	25.5	1.7	1.3	-	0.3	-
Rhagionidae	0.2	-	1.0	-	1.5	-	2.4	-	0.4	25.1	-	-
Simuliidae	-	-	-	0.8	-	83.3	0.8	8.7	1.3	-	-	4.8
Blepharoceridae	-	-	-	-	-	-	0.1	-	-	-	-	-
Tabanidae	-	-	-	-	-	0.4	Tr	-	-	-	-	-
Dolichopopidae												
Empididae	-	-	-	0.2	0.8	-	0.9	0.6	-	4.5	-	-
Coleoptera												
Carabidae												
Chrysomelidae												
Elmidae	12.6	2.5	6.2	4.2	0.3	-	6.5	1.2	6.8	-	44.5	-
Gyrinidae	-	-	-	-	2.6	-	-	-	0.4	-	-	-
Hydrophilidae	0.3	-	-	-	-	-	-	1.7	-	-	-	-
Psephenidae	5.0	28.7	4.1	5.5	0.8	0.4	-	-	1.5	6.0	1.3	-
Mollusca												
Gastropoda												
Ctenobranchiata												
Pleuroceridae	18.0	10.0	6.2	3.4	5.2	-	-	-	5.5	4.5	11.5	-
Amnicolidae												
Physidae												
Ancylidae	-	-	0.2	-	-	-	-	-	-	-	-	-
Pelecypoda												
Unionidae	0.5	-	-	-	-	-	-	-	-	-	-	-
Sphaeridae	-	1.2	-	-	-	-	-	-	-	-	-	-

Diversity of mussel species (Table 3) increases downstream from headwater areas, where only two species were found, to just above Saltville, where nine species were collected in 1973. Below Saltville, only one species (*Lampsilis fasciola*) was collected. In 1913, Ortman reported more than thirty species from the same stretch of river. Since many of these species were big river forms and not found above Saltville and no longer present in the badly polluted Holston River, they will probably never become reestablished except through transplants from other systems. The fact that no invasion has occurred from upstream areas can be attributed in part to their complex life cycle and sedimentary habits (Cairns, 1970), but the continued existence of limiting concentrations of toxic materials dissolved in the water and precipitated in the river sediments cannot be neglected.

Fish

The diversity of fishes typically increases longitudinally from headwater areas of streams to their mouth (Sheldon, 1968). Collections to date in the North Fork (Figures 3 and 4) indicate that the diversity of fish increased in 1973 and 1974 at the lowermost sampling station, but continues to be suppressed in areas immediately below Saltville. Since there is an adequate pool of upstream species (Table 4) to allow colonization of downstream areas, their absence in areas immediately below Saltville (River Mile 70 to 79) must be attributed to the continued existence of unsatisfactory habitat conditions. Increases in the number of fish species in 1973 and 1974 at the lowermost sampling station (River Mile 0.2 to 6.3) attests to the fact that adequate time for some colonization has passed.

Table 3. Relative abundance of Mussels in the North Fork Holston River above and below Saltville, Virginia (approximately river mile 83). A=abundant; M=moderately abundant; O=occasional. Dashed lines represent the absence of a species at a particular station.*

	River Mile					
	115.6	106.0	86.9	79	45	6.3
Actinonaias pectorosa	-	-	M	-	-	-
Cyclonaias tuberculata	-	O	-	-	-	-
Fusconaia barnesiana	-	A	A	-	-	-
Fusconaia edgariana	-	-	A	-	-	-
Lampsilis fasciola	-	M	M	-	-	O
Lasmigona costata	-	-	O	-	-	-
Medionidus conradicus	A	A	A	-	-	-
Micromya vanuxemensis	A	A	A	-	-	-
Micromya nebulosa (complex)	-	-	-	-	-	-
Micromya sp.	-	O	-	-	-	-
Pleurobema oviforme	-	-	O	-	-	-
Ptychobranchus subtenum	-	-	M	-	-	-

*Mussel data provided by Sally Dennis, TVA, FF&WD.

Table 4. Percentage composition of fishes in the North Fork Holston River, 1971-1974.

Species	River Mile 88.6		River Mile 70				River Mile 6.3			
	June 30 1971	Sept. 4 1973	June 29 1971	June 15 1972	July 10 1973	June 11 1974	June 28 1971	June 16 1972	July 9 1973	June 11 1974
Rainbow trout	-	-	-	0.5	-	-	-	-	-	-
Stoneroller	0.7	7.5	0.2	1.4	7.9	5.2	2.9	0.6	8.4	1.2
Goldfish	-	-	-	-	-	-	-	0.1	TR	-
Carp	-	-	-	0.5	-	-	-	-	TR	-
Bigeye chub	12.2	6.3	47.9	25.7	11.2	3.3	0.7	0.7	6.8	4.9
Streamline chub	0.6	1.9	-	-	-	0.8	6.6	11.1	4.0	17.5
River chub	1.4	6.8	-	0.5	1.1	-	2.9	0.6	9.1	3.3
Popeye shiner	1.5	-	0.8	-	-	0.2	-	0.5	2.0	8.9
Striped shiner	7.9	5.3	8.6	4.3	5.9	6.4	3.2	4.7	13.8	8.8
Warpaint shiner	3.2	7.7	-	1.4	9.8	0.4	4.1	1.2	4.1	4.7
Whitetail shiner	1.9	2.6	0.6	9.0	16.2	9.2	25.1	21.7	9.8	16.1
Tennessee shiner	5.4	19.8	-	0.5	0.8	-	-	-	0.9	0.2
Silver shiner	1.6	2.9	1.2	1.4	11.3	1.0	-	1.8	2.4	6.1
Rosyface shiner	3.3	1.2	0.2	-	1.2	52.4	-	-	0.4	7.9
Saffron shiner	-	-	-	-	-	-	-	-	-	-
Sawfin shiner	1.3	TR	3.4	0.5	0.7	6.0	1.9	0.5	2.0	3.7
Steelcolor shiner	-	-	-	-	-	-	-	-	-	-
Spotfin shiner	0.4	-	-	-	-	-	-	-	-	-
Telescope shiner	41.8	9.8	1.5	-	6.5	0.1	0.5	1.4	2.2	6.1
Mimic shiner	0.2	-	-	-	-	-	-	-	-	-
Stargazing minnow	0.5	3.2	-	-	-	7.5	2.2	21.7	2.6	4.8
Bluntnose minnow	-	-	-	-	-	-	-	0.1	-	-
Blacknose dace	0.1	0.1	-	-	0.1	-	-	-	-	-
Creek chub	-	0.2	-	-	0.1	-	-	-	TR	-
Quillback carpsucker	-	-	-	-	-	-	-	-	-	-
Northern hogsucker	0.7	5.2	3.8	5.7	15.4	1.5	11.0	5.6	5.9	1.5
Black redhorse	3.7	2.9	0.1	0.5	1.9	-	1.2	0.4	1.2	0.6
Golden redhorse	5.5	2.1	-	-	-	-	0.5	-	1.0	0.3

Yellow bullhead	-	-	1.6	7.1	4.2	-	1.9	1.4	10.3	0.3
Channel catfish	-	-	0.8	3.8	1.0	-	-	-	1.1	0.1
Mountain madtom	-	-	-	-	-	-	-	-	-	0.5
Margined madtom	0.5	4.9	-	-	-	0.1	-	-	-	-
Flathead catfish	0.1	-	-	-	-	-	-	0.1	0.2	0.2
Northern studfish	-	TR	0.9	-	0.1	-	1.2	0.4	0.1	-
Rockbass	2.8	2.0	0.5	8.1	-	0.1	7.3	8.4	4.4	0.3
Redbreast sunfish	0.1	-	9.4	17.6	0.4	-	-	13.1	0.6	0.2
Bluegill	0.5	-	2.4	-	0.3	-	-	-	TR	-
Redear sunfish	-	-	-	1.4	-	-	-	-	-	-
Longear sunfish	0.4	0.1	9.1	-	0.3	-	7.1	1.1	-	-
Smallmouth bass	0.5	0.9	0.9	1.0	0.3	0.1	18.5	2.9	5.7	0.7
Largemouth bass	-	-	-	-	-	-	-	-	-	-
Greenside darter	0.1	0.6	0.9	3.8	1.1	0.1	-	0.2	0.1	0.1
Bluebreast darter	-	-	-	-	-	-	-	-	-	-
Spotted darter	0.5	0.6	-	-	-	0.1	-	-	-	-
Redline darter	-	1.6	4.4	1.0	0.6	3.5	0.5	-	0.1	0.2
Tennessee snubnose darter	0.1	0.2	0.2	2.8	1.2	0.2	-	-	0.2	-
Banded darter	0.1	TR	0.3	1.0	-	1.3	-	-	0.2	0.1
Tangerine darter	-	0.2	-	-	0.2	-	-	0.1	-	-
Logperch	0.3	0.2	-	-	-	-	-	-	-	-
Gilt darter	-	-	0.1	-	-	0.5	-	-	TR	0.6
Longhead darter	0.1	-	-	-	-	-	-	-	-	-
Dusky darter	-	TR	-	-	-	-	-	-	-	-
Banded sculpin	-	3.2	0.2	0.5	0.2	-	-	-	0.3	0.1
Unidentified	-	-	-	-	-	-	0.7	-	-	-

The golden redhorse and flathead catfish are two species which have apparently become established in the section of river near its mouth, but not in sections immediately downstream of Saltville. The logperch occurs regularly above Saltville but has not been taken in any of the downstream sections. The spotted darter and margined madton appeared in 1974 to be making incursions from upstream areas.

In summary, these data suggest that limiting habitat conditions resulting from the continued input of toxic materials from the abandoned waste lagoons is at least slowing and will probably limit functional biological recovery in the North Fork Holston River. As a result of dilution and sedimentation, the effects of these pollutants are not as profound in the lowermost reaches of the river.

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