SURVEY OF BENTHIC MACROINVERTEBRATES AND ANALYSIS OF WATER AND SEDIMENT FROM THE BUFFALO RIVER

1969

PREPARED FOR

Allied Chemical Corporation
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BY

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PREFACE

This report, which is a product of a study funded by the Allied Chemical Corporation of Buffalo, New York, is intended to provide information on benthic macroinvertebrates and the analysis of water and sediment from the Buffalo River.

Special Reports are issued by the Great Lakes Laboratory as a means of making preliminary data available to the university community and the general public. These reports do not constitute formal publication.

Other publications in this series include:

NUMBER	TITLE
1	Selected References Concerning the Algae of Lake Erie. (Updated in Special Report #6)
3	Fish Protein Concentrate: A Review of Pertinent Literature with an Emphasis on Production from Freshwater Fish. (Out of Print)
4	Algae as Indicators of Pesticides.
5	Fish Protein Concentrate: A Review of Pertinent Literature with an Emphasis on Production from Freshwater Fish. II - A Supplement. (Out of Print)

NUMBER	TITLE
6	Selected References Concerning the Algae of Lake Erie. II.
7	Fish Protein Concentrate: Protein Value of Lake Erie Carp, Sheepshead and Alewife as Raw Material. (Out of Print)
8	Survey of Benthic Macroinvertebrates and Analysis of Water and Sediment from the Buffalo River - 1970.
9	Chromium, Cadmium, Arsenic, Selenium, Mercury and Aquatic Life: A Brief Literature Review.
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15	Bibliography of Water Quality Data for Erie and Niagara Counties.

NUMBER	TITLE
16	Measurement of Primary Productivity in Freshwater via the Uptake of Radioactive Carbon.
17	Clarification of Marine Regulations and Enforcement for Non-Commercial Craft - Greater Buffalo Area.
18	Benthic Survey - A Comparison of Various Bio-Indexing Systems Applied to Benthic Macroinvertebrate Data.

Additional copies of these reports can be obtained from the Great Lakes Laboratory.

Robert A. Sweeney
Director
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INTRODUCTION

For the second consecutive year, the Allied Chemical Corporation of Buffalo awarded a grant for the quantitative analysis of water, sediment and macroscopic benthic organisms from the Buffalo River[1] to the Great Lakes Laboratory through the Research Foundation of the State University of New York. The purpose of this award was two-fold.

The investigation provided information on the effectiveness of the Buffalo River Improvement Project. The Improvement Project is a cooperative effort between industry and the city government through which water from the Buffalo Harbor is being used in industrial cooling and low flow augmentation. A minimum of 100 million gallons per day (100 MGD) is pumped from the harbor (See Pump House and Water Intake Structure on Figure 1) to four industries (Allied Chemical, Donner-Hanna Coke, Mobil Oil and Republic Steel) along the river where it is used to cool and dilute

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[1]NOTE: For the purpose of this report, the Buffalo River is that stream which is formed by the junction of Buffalo and Cayuga Creeks. This is the United States Geological Survey's definition of the Buffalo River.

A detailed description of the Buffalo River's tributaries (31) and drainage basin (436 square miles) can be found in: W.E. Harding and B.K. Gilbert. 1968. Erie-Niagara Basin Surface Water. Erie-Niagara Basin Regional Water Resources Planning Board. Report 2. 118 p.

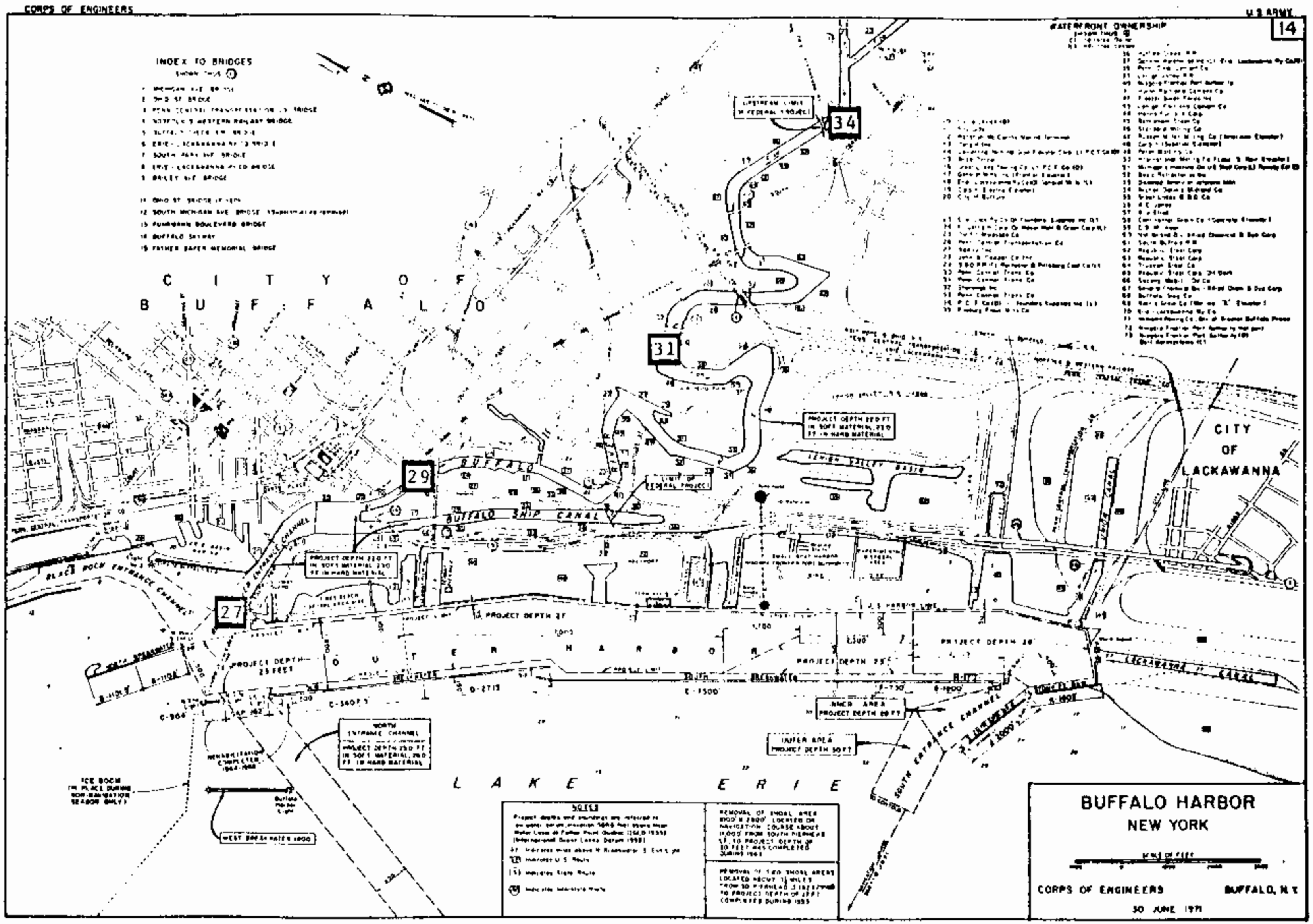

Figure 1. Map of Buffalo River and Surrounding Area.

wastes, then it is discharged into the river.

The investigation also provided an opportunity for college students to apply some of the knowledge and techniques that they had learned. They also participated in the organization and evaluation of data. Such practical experiences generally cannot be gained solely in the classroom.

METHODS

Four stations were established on the Buffalo River:

Station 27	-	at the Fuhrmann Boulevard Coast Guard Base
Station 29	-	below the Michigan Avenue Bridge
Station 31	-	below the New York Central Railroad Bridge
Station 34	-	below the Erie-Lackawanna Railroad Bridge

The location of these sites is shown on Figure 1. Water samples were collected from two meters below the surface at mid-stream using a 1200 ml Kemmerer on 2 June, 30 July and 22 September 1969. The water was analyzed according to Standard Methods (American Public Health Association 1965) and the Laboratory Manual of the Cleveland Program Office of the Federal Water Pollution Control Administration (1967). Oxygen was fixed in the field using the Rideal-Stewart Technique. Alkalinity, pH (via Coleman Model 37A pH meter) and conductivity (via Yellow Springs Instrument Model 31 Conductivity Bridge) were performed immediately. Samples were refrigerated while the final tests were completed.

Sediment samples for chemical and macroinvertebrate analyses were gathered with a six inch Ekman Dredge at the same times and sites as the water. Likewise, the above references were employed in the analysis of the mud.

The macroinvertebrates were removed by passing each sample through #6 and #30 standard sieves. The animals were fixed (killed) and preserved in a solution of ethyl alcohol, distilled water and glycerin (75:20:5 by weight). Dr. Ronald Engel of the State University College at Oswego assisted with the quantitative and qualitative analyses. The taxonomic system employed was that of Pennak (1953). Results were equated to organisms per square meter.

RESULTS

Tables 1 through 6 contain the data collected during 1969.

A laboratory accident and instrument failure resulted in the loss of temperature-oxygen results of 30 July.

Table 1a

WATER ANALYSIS PER STATION

Station	Date	pH	Alkal. mg/l	Cond. µmhos at 25°C	D.O. mg/l	D.O. percent saturation	Temp. °C	SOLIDS Dissolved mg/l	SOLIDS Suspended mg/l	SOLIDS Total mg/l
27	6/2	7.510	93.3	166	10.0	100	23.0	104	116	220
27	7/30	7.991	92.2	180	----	---	----	88	204	292
27	9/22	7.614	94.8	170	7.33	87	25.5	156	118	274
29	6/2	6.930	93.3	326	0.60	6	23.0	236	104	340
29	7/30	7.567	89.2	297	----	---	----	140	20	160
29	9/22	6.955	84.1	246	0.03	<1	26.0	134	114	248
31	6/2	6.670	76.0	389	0.00	0	23.0	320	146	466
31	7/30	7.270	72.4	341	----	---	----	184	204	388
31	9/22	6.741	69.0	295	0.00	0	27.5	192	258	450
34	6/2	7.350	134.0	296	3.60	41	24.0	310	62	372
34	7/30	7.629	103.0	229	----	---	----	138	196	334
34	9/22	7.145	84.8	216	0.27	~3	24.5	198	218	416

Table 1b

WATER ANALYSIS PER STATION

Station	Date	PHOSPHATES Dissolved mg/l	PHOSPHATES Suspended mg/l	PHOSPHATES Total mg/l	NITROGEN NO_3-N mg/l	NITROGEN Org-N mg/l	NITROGEN NH_4-N mg/l	NITROGEN Total-N mg/l
27	6/2	0.14	0.14	0.28	0.40	0.84	1.00	2.24
27	7/30	0.07	0.19	0.26	0.28	0.56	0.90	1.74
27	9/22	0.14	0.08	0.22	0.48	0.93	1.00	2.41
29	6/2	0.06	0.94	2.00	0.29	0.93	4.39	5.61
29	7/30	0.20	0.90	1.10	0.14	0.84	3.38	4.36
29	9/22	0.15	0.55	0.70	0.31	1.30	3.55	5.16
31	6/2	0.33	0.31	0.64	0.35	1.12	4.62	6.09
31	7/30	0.09	0.87	0.96	0.43	1.31	4.52	6.16
31	9/22	0.16	0.56	0.72	0.35	1.86	4.44	6.65
34	6/2	0.32	1.24	1.56	2.20	0.65	3.17	6.02
34	7/30	0.08	0.78	0.86	0.33	1.21	3.28	4.82
34	9/22	0.17	0.47	0.64	0.28	1.58	2.95	4.81

Table 2a

WATER ANALYSIS PER DATE

Station	Date	pH	Alkal. mg/l	Cond. µmhos at 25°C	D.O. mg/l	D.O. percent saturation	Temp. °C	SOLIDS Dissolved mg/l	SOLIDS Suspended mg/l	SOLIDS Total mg/l
27	6/2	7.510	93.3	166	10.00	100	23.0	104	116	220
29	6/2	6.930	93.3	326	0.60	6	23.0	236	104	340
31	6/2	6.670	76.0	389	0.00	0	23.0	320	146	466
34	6/2	7.350	134.0	296	3.60	41	24.0	310	62	372
27	7/30	7.991	92.2	180	----	--	----	88	204	292
29	7/30	7.567	89.2	297	----	--	----	140	20	160
31	7/30	7.270	72.4	341	----	--	----	184	204	388
34	7/30	7.629	103.0	229	----	--	----	138	196	334
27	9/22	7.614	94.8	170	7.33	87	25.5	156	118	274
29	9/22	6.955	84.1	246	0.03	<1	26.0	134	114	248
31	9/22	6.741	69.0	295	0.00	0	27.5	192	258	450
34	9/22	7.145	84.8	216	0.27	~3	24.5	198	218	416

Table 2b

WATER ANALYSIS PER DATE

Station	Date	PHOSPHATES Dissolved mg/l	PHOSPHATES Suspended mg/l	PHOSPHATES Total mg/l	NITROGEN NO_3-N mg/l	NITROGEN Org-N mg/l	NITROGEN NH_4-N mg/l	NITROGEN Total-N mg/l
27	6/2	0.14	0.14	0.28	0.40	0.84	1.00	2.24
29	6/2	0.06	0.94	2.00	0.29	0.93	4.39	5.61
31	6/2	0.33	0.31	0.64	0.35	1.12	4.62	6.09
34	6/2	0.32	1.24	1.56	2.20	0.65	3.17	6.02
27	7/30	0.07	0.19	0.26	0.28	0.56	0.90	1.74
29	7/30	0.20	0.90	1.10	0.14	0.84	3.38	4.36
31	7/30	0.09	0.87	0.96	0.43	1.31	4.52	6.16
34	7/30	0.08	0.78	0.86	0.33	1.21	3.28	4.82
27	9/22	0.14	0.08	0.22	0.48	0.93	1.00	2.41
29	9/22	0.15	0.55	0.70	0.31	1.30	3.55	5.16
31	9/22	0.16	0.56	0.72	0.35	1.86	4.44	6.65
34	9/22	0.17	0.47	0.64	0.28	1.58	2.95	4.81

Table 3a

SEDIMENT ANALYSIS PER STATION

Station	Date	Total Solids %	Volatile Solids %	Fixed Solids %	Oil mg/g	Chemical Oxygen Demand mg/g	Biochemical Oxygen Demand mg/g	Chlorine Demand mg/g	Iron mg/g
27	6/2	47.93	8.09	91.91	6.92	86.6	11.30	11.3	59.6
27	7/30	39.09	7.14	92.86	6.20	71.1	8.72	13.1	44.4
27	9/22	48.60	8.33	91.67	9.82	94.2	12.80	13.0	54.9
29	6/2	48.80	11.06	88.94	8.70	91.2	10.60	12.3	48.0
29	7/30	36.56	8.38	91.62	7.74	102.0	15.10	19.5	54.4
29	9/22	6.93	10.35	89.65	14.20	137.0	23.00	34.8	52.7
31	6/2	43.61	6.76	93.24	6.62	82.3	8.51	11.3	60.4
31	7/30	53.06	6.85	93.15	7.91	82.4	7.83	10.4	63.5
31	9/22	33.19	13.33	86.67	27.20	225.0	23.80	22.2	64.6
34	6/2	49.10	7.77	92.23	4.70	63.0	12.90	10.9	29.4
34	7/30	43.68	8.38	91.62	15.10	83.8	15.60	9.9	38.4
34	9/22	27.43	9.76	90.24	19.10	128.0	22.70	17.9	36.6

Table 3b

SEDIMENT ANALYSIS PER STATION

Station	Date	PHOSPHATE Dissolved mg/g	PHOSPHATE Total mg/g	NITROGEN NO_3-N mg/g	NITROGEN Org-N mg/g	NITROGEN NH_4-N mg/g	NITROGEN Total-N mg/g
27	6/2	0.0048	3.31	0.096	2.04	0.393	2.53
27	7/30	0.0032	3.72	0.077	1.88	0.271	2.23
27	9/22	0.0026	5.28	0.025	2.19	0.165	2.38
29	6/2	0.0050	3.46	0.083	2.15	0.286	2.52
29	7/30	0.0041	5.31	0.063	2.62	0.360	3.04
29	9/22	0.0113	8.55	0.180	6.83	0.896	7.91
31	6/2	0.0036	2.32	0.071	1.76	0.299	2.13
31	7/30	0.0013	2.89	0.027	1.37	0.294	1.69
31	9/22	0.0047	5.93	0.024	3.66	0.399	4.03
34	6/2	0.0043	2.10	0.041	2.73	0.494	3.27
34	7/30	0.0046	3.68	0.030	1.82	0.244	2.09
34	9/22	0.0069	4.70	0.023	3.72	0.340	4.08

Table 4a
SEDIMENT ANALYSIS PER DATE

Station	Date	Total Solids %	Volatile Solids %	Fixed Solids %	Oil mg/g	Chemical Oxygen Demand mg/g	Biochemical Oxygen Demand mg/g	Chlorine Demand mg/g	Iron mg/g
27	6/2	47.93	8.09	91.91	6.92	86.6	11.30	11.3	59.6
29	6/2	48.80	11.06	88.94	8.70	91.2	10.60	12.3	48.0
31	6/2	43.61	6.76	93.24	6.62	82.3	8.51	11.3	60.4
34	6/2	49.10	7.77	92.23	4.70	63.0	12.90	10.9	29.4
27	7/30	39.09	7.14	92.86	6.20	71.1	8.72	13.1	44.4
29	7/30	36.56	8.38	91.62	7.74	102.0	15.10	19.5	54.5
31	7/30	53.06	6.85	93.15	7.91	82.4	7.83	10.4	63.5
34	7/30	43.68	8.38	91.62	15.10	83.8	15.60	9.9	38.4
27	9/22	48.60	8.33	91.67	9.82	94.2	12.80	13.0	54.9
29	9/22	6.93	10.35	89.65	14.20	137.0	23.00	34.8	52.7
31	9/22	33.19	13.33	86.67	27.20	225.0	23.80	22.2	64.6
34	9/22	27.43	9.76	90.24	19.10	128.0	22.70	17.9	36.6

Table 4b

SEDIMENT ANALYSIS PER DATE

		PHOSPHATE		NITROGEN			
Station	Date	Dissolved mg/g	Total mg/g	NO_3-N mg/g	Org-N mg/g	NH_4-N mg/g	Total-N mg/g
27	6/2	0.0048	3.31	0.096	2.04	0.393	2.53
29	6/2	0.0050	3.46	0.083	2.15	0.286	2.52
31	6/2	0.0036	2.32	0.071	1.76	0.299	2.13
34	6/2	0.0043	2.10	0.041	2.73	0.494	3.27
27	7/30	0.0032	3.72	0.077	1.88	0.271	2.23
29	7/30	0.0041	5.31	0.063	2.62	0.360	3.04
31	7/30	0.0013	2.89	0.027	1.37	0.294	1.69
34	7/30	0.0046	3.68	0.030	1.82	0.244	2.09
27	9/22	0.0026	5.28	0.025	2.19	0.165	2.38
29	9/22	0.0113	8.55	0.180	6.83	0.896	7.91
31	9/22	0.0047	5.93	0.024	3.66	0.399	4.03
34	9/22	0.0069	4.70	0.023	3.72	0.340	4.08

Table 5

BENTHIC MACROINVERTEBRATE ANALYSIS PER STATION

Station	Date	Class	Order	Family	#/m^2
27	6/2	Oligochaeta	Plesiophora	-	2,449.0
	7/30	Oligochaeta	Plesiophora	-	18,467.5
		Insecta	Diptera	Chironomidae	821.5
		Pelecypoda	Heterodonta	Sphaeriidae	31.0
		Gastropoda	Ctenobranchiata	Valvatidae	31.0
		Gastropoda	Pulmonata	Physidae	31.0
	9/22	Oligochaeta	Plesiophora	-	4,712.5
		Insecta	Diptera	Chironomidae	139.5
		Gastropoda	Ctenobranchiata	Valvatidae	108.5
29	6/2	Oligochaeta	Plesiophora	-	15.5
	7/30	Oligochaeta	Plesiophora	-	62.0
	9/22	Oligochaeta	Plesiophora	-	93.0
31	6/2	No Specimens Found			
	7/30	No Specimens Found			
	9/22	No Specimens Found			
34	6/2	Oligochaeta	Plesiophora	-	837.0
	7/30	Oligochaeta	Plesiophora	-	3,689.0
	9/22	No Specimens Found			

Table 6

BENTHIC MACROINVERTEBRATE ANALYSIS PER DATE

Station	Date	Class	Order	Family	#/m²
27	6/2	Oligochaeta	Plesiophora	-	2,499.0
29		Oligochaeta	Plesiophora	-	15.5
31		No Specimens Found			
34		Oligochaeta	Plesiophora	-	837.0
27	7/30	Oligochaeta	Plesiophora	-	18,467.5
		Insecta	Diptera	Chironomidae	821.5
		Pelecypoda	Heterodonta	Sphaeriidae	31.0
		Gastropoda	Ctenobranchiata	Valvatidae	31.0
		Gastropoda	Pulmonata	Physidae	31.0
29		Oligochaeta	Plesiophora	-	62.0
31		No Specimens Found			
34		Oligochaeta	Plesiophora	-	3,689.0
27	9/22	Oligochaeta	Plesiophora	-	4,712.5
		Insecta	Diptera	Chironomidae	139.5
		Gastropoda	Ctenobranchiata	Valvatidae	108.5
29		Oligochaeta	Plesiophora	-	93.0
31		No Specimens Found			
34		No Specimens Found			

DISCUSSION

It should be noted that no dredging by the Corps of Engineers occurred at and upstream from the Michigan Avenue Bridge (Station 29) during the 1969 sampling period. The river bottom adjacent to the Coast Guard Base (Station 27) was dredged by the Corps' hopper dredge, the LYMAN, 14 days prior to the time when the last collection was made.

Another factor that should be kept in mind is that the lake level was approximately 30 cm higher during the 1969 sampling period than in 1968. The lake level has a strong influence on the discharge of the river. The higher the lake, the lower the discharge of the river. Hence, the average discharge was less in 1969 than 1968.

Contrasting changes in water quality per station with time (Tables 1a and 1b), the highest values for the parameters measured occurred 2 June. This was particularly evident at Station 34, which is situated approximately 100 meters above the upstream terminus of the Improvement Project's discharges. The high values for conductivity, dissolved oxygen and dissolved solids correlate with the field observations that water was flowing from the tributaries (Buffalo, Cayuga and Czenovia Creeks) into and down the river. However, on 30 July and 22 September this was not the case. There was no flow observed at Station 34. However, the river was flowing towards the lake at the other sampling sites.

Comparing changes in water chemistry between stations on a sampling date (Tables 2a and 2b), the highest values measured and poorest quality observed were at Station 31. For example, the dissolved oxygen at the times and depth that samples were collected was zero, while the ammonia was 4.4 mg/l or higher. Ammonia concentrations above 2.0 mg/l (parts per million) are considered to be toxic to most desirable forms of life such as trout and other game fish (Brockway 1950). A "better" quality water was observed at Station 27 where some mixing of river and lake water does occur.

Compared with the results obtained in 1968 (Sweeney 1968a), there was a marked decline in conductivity and dissolved solids while suspended solids increased. Ammonia and total nitrogen levels generally were higher in 1969 than in 1968. While there did not appear to be a slug of pollutants in the river, the significant differences between the values of the stations (#34, #31 and #29) on the river with the station at the mouth (#27) did indicate general "sluggishness." This was undoubtedly due in part to the height of the water in the lake, as discussed above.

Examining the sediment data reveals results that differ from those obtained from the water. Contrasting changes in chemical quality per station with time (Tables 3a and 3b), the highest measured values generally occurred on 9 September. This may have been due to the fact that the river appeared to be flowing slower at this point in time. Hence, the carrying capacity of the river was low and more material settled on the bottom.

In regards to changes in sediment chemistry between stations on a sampling date (Tables 4a and 4b), only Station 29 had somewhat higher values for most parameters. However, this is somewhat misleading, since the low total solid content in the sample collection on 22 September at this site increased the computed values for phosphates and nitrogens. It is believed that the bubble screen that had been installed by Cornell Aeronautical Laboratory at collection site 29 was responsible, in part, for the displacement of the lighter sediment from this area.

Contrasting the above results with those generated last year (Sweeney 1968b), the quality of the sediment generally has improved, particularly with respect to oil, chemical and biochemical oxygen demand and chlorine demand. Iron, most likely from Donner-Hanna Coke and Republic Steel, was still highest at Station 31. However, the quantites in 1969 were less than the amounts found in 1968.

Marked differences in the quality and quantity of bottom organisms were noted between stations on the same date and between samples taken on different dates at the same station. An exception to the latter was Station 31 from which no benthic macroinvertebrates were collected. In contrast, the sampling site at the mouth of the river (Station 27) provided the largest taxonomic range and number of bottom dwellers.

The decrease in the number and variety of organisms observed between 30 July and 22 September at Station 27 may have been due to the dredging by the U.S. Army Corps of Engineers, which occurred 14 days prior to sampling. The lower number of insects at Station 27 in September also may have been caused by the maturation and migration of these organisms, which occurs in the late summer. (Change from bottom dwelling to flying forms.)

Cornell Aeronautical Lab's air curtain appeared to have less of an effect on the macroinvertebrates than on the chemistry of the sediment.

Contrasting the above results with those obtained in previous years (Sweeney 1968c; Blum 1963, 1964), there has been an improvement in quality of the benthic environment at the mouth of the river (Station 27). This is evident by an increase in the quantity and quality of organisms. For example, snails (Gastropoda) and immature insects (Insecta) were found in 1969, but were not observed in 1968.

The significant increase during June and July in sludge worms (Oligochaeta) just above the upstream terminus of the Improvement Project (Station 34) also was indicative of a positive change. However, the worms were not present in September. Their disappearance correlated with a decrease in the quality of the sediment, particularly with regards to chlorine demand, chemical and biochemical oxygen demand (COD and BOD) and oil. These changes may have been due, in part, to the pooling of the river in this area.

No significant changes in the bottom organisms were noted at the New York Central Railroad Bridge (Station 31). Hence, it must be concluded from the chemical and biological data which were gathered that there was no evidence of improvement in this specific region of the river.

CONCLUSIONS AND RECOMMENDATIONS

Each of the three students - Richard Cobler, Robert Stadelmaier and John Underwood - who participated in the research, benefited from the experience. They each have demonstrated a deeper understanding of the techniques and problems concerning the generation and interpretation of aquatic data.

Regarding the above results, with higher lake levels being forecast by the Corps of Engineers for 1970, it appears that increased pumping rates on the part of the Buffalo River Improvement Project coupled with more efficient pollution abatement procedures by the corporations along the river may be necessary if the quality of the water is to be maintained or improved. The project was hard pressed to maintain a positive flow in September 1969, a period of high evaporation and low precipitation.

From the above data, one can conclude that during the past year some regions of the river, particularly at the mouth, have improved in quality. While the organisms are typically found in an environment with high levels of organic pollution, the fact that they are present in increasing numbers is an indication of positive changes.

The environmental quality of other sections of the river have not been markedly altered. This further indicates that a greater effort is needed to increase the rate of flow and reduce the oil, iron and chemical oxygen demand.

While pollution abatement by industries along the river, dredging by the Corps and the Buffalo River Improvement Project generally have improved the quality of the river downstream from the Mobil Oil Refinery, the pumping project has not aided some problems upstream. As a result of the cooling water discharges, the river flows upstream or is stagnant above Station 34. Hence, a pool of water from Cazenovia, Buffalo and Cayuga Creeks, each of which receive the discharges from storm sewer overflows and/or sewage "treatment" plants, is created above the project in the area of the Bailey Avenue bridges. A mechanism is necessary to augment the flow of these tributaries while reducing the amount of domestic sewage that they contain. These accumulated pollutants are carried to Lake Erie in the early spring with runoff from melting snow. In passing down the river and into the lake, they probably undo many of the benefits of the Improvement Project. This is similar to spending a day washing the floor and then giving it a final rinse with filthy water.

It is strongly recommended that a Buffalo River Basin Commission, with representation from county and city governments, industry and other involved agencies, be established to formulate comprehensive solutions to the problems that exist on the river and its tributaries.

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