A SURVEY OF THE BENTHIC MACROINVERTEBRATES OF THE BUFFALO RIVER AND A COMPARISON TO PAST SURVEYS AND A DIFFERENT METHOD OF COLLECTION

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May 14, 1989

INTRODUCTION

People`s use of the Buffalo River have degraded it into one of the most seriously polluted streams in America. Recently, efforts have been and are still being made to clean up the river. The purposes of this study are to determine the present environmental quality of the Buffalo River by looking at the benthic macroinvertebrates and to examine changes in the quality of the river by comparing the results of this survey with previous surveys. Benthic macroinvertebrates have been used as indicators of environmental quality of streams and other bodies of water (Howmiller and Scott, 1976).

Several studies have been done in the past on the Buffalo River. In surveys done before 1974, the organisms were not keyed below family level, reducing the value of the data acquired. Resh and Unzicker (1975) noted the importance of keying benthic organisms to species where possible (Bergantz, 1977).

Macroinvertebrates are "large" invertebrates. The many freshwater forms include aquatic insects and other arthropods, snail, clams, and worms. Analysis of macroinvertebrates is one of the most reliable and cost effective approaches to biological monitoring because:

1. they are very sensitive to environmental disturbances,
2. they are less mobile than fish and cannot as easily avoid intermittent pollution,
3. they indicate the condition of the sediment, and
4. their populations are more stable than those of microorganisms, thus providing less sampling variability (Simpson, 1976).

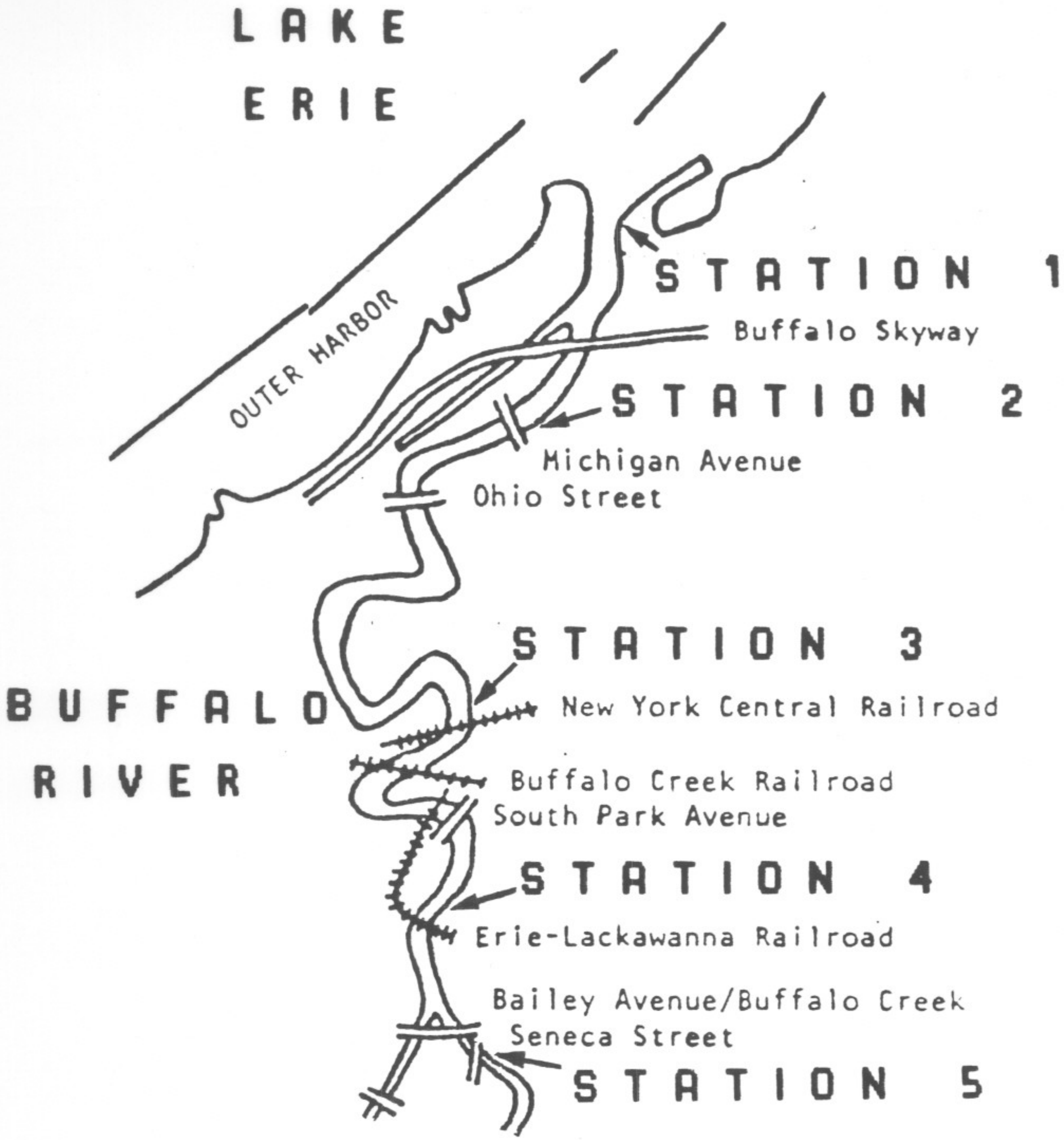

FIGURE 1

Map of Buffalo River showing locations of the sampling stations.

The data is usually reduced to some sort of numerical index. There are several indices that have been developed. Some use the concept of species diversity to determine environmental quality. One is a measure of species richness and of the equitability of distribution of individuals among species. Some indices are based on the presence or abundance of some group or groups of organisms which are comprised of many species, such as the oligochaete worms (Howmiller and Scott, 1976).

There are several methods used in collection samples. The Ponar grab was used in this survey. Another method of collecting samples is the multiplate sampler, which is used by the NYS Department of Environmental Conservation (DEC). The results of this survey are compared to the DEC results as well as with past studies.

MATERIALS AND METHODS

Five stations were established along the Buffalo River and the Buffalo Creek tributary (see figure 1). Stations 1 through 4 were located in the dredged section of the Buffalo River. Station 5 was located in the Buffalo Creek just upstream of the Seneca Street bridge. Station 1 was at the mouth of the river. Station 2 was between the Skyway bridge and Michigan Ave. bridge. Station 3 was just downstream of the Penn Central RR bridge. Station 4 was just downstream of the upper Erie-Lackawanna RR bridge.

Samples were collected in the summer of 1988 using a Wilder Co. mini Ponar grab. The mini Ponar grab was dropped in 2 places at each station, one in midstream and one near the south bank of the river. If the grab was not full, it was discarded and the drop repeated. The samples were sieved through a No. 30 mesh sieve and the material retained by the sieve was preserved in a 10% formalin solution.

In the lab the samples were again rinsed in a No. 30 mesh sieve and put into 70% ethyl alcohol solution. A small amount of Rose Bengal was added to each sample. This stained any tissue in the sample, making the organisms easier to pick out.

The macroinvertebrates were picked from the samples using a binocular 10X dissecting microscope, separated into major taxa and represerved in 70% ethyl alcohol solution.

Due to the large number of oligochaetes in each sample, a subsample of 50 specimens was randomly selected from each sample for identification. The total number of individuals for each specie in the entire sample was estimated from those 50.

The oligochaetes were permanently mounted on slides using Hydramount no. 89250 and protected with a cover slip. The chironomids were temporarily mounted on slides in glycerin after a slit was made on the ventral side of the animal between the head and the first segment of the thorax. Both were identified to specie where possible using a binocular light microscope with 100X - 1000X magnification. All other taxa were identified using the binocular 10X dissecting microscope.

Data from this survey was compared with a survey done by Bergantz (1977) using the mini Ponar grab, and with a survey done by the DEC in 1987 using a multiplate sampler. The multiplate sampler consists of 3 plates tempered hardwood, 6 inches square and 1/8 inch thick, mounted on a no. 13 aluminum turnbuckle. The upper two plates are separated by one inch and the lower plates by 3/8 inch. The samplers were installed three feet below the surface (Simpson and Bode, 1980).

References used in identification of the organisms were:

Oligichaeta	–	Brinkhurst, 1980
Polychaetae	–	Pennak, 1978
Hirudinae	–	Pennak, 1978
Turbellaria	–	Pennak, 1978
Isopoda	–	Pennak, 1978
Chironomidae	–	Mason, 1973 Simpson and Bode, 1980
Culicidae	–	Pennak, 1978
Trichoptera	–	Pennak, 1978
Gastropoda	–	Harman and Berg, 1971 Mackie et al, 1980
Pelecypoda	–	Mackie et al, 1980 Herrington, 1962

RESULTS

The macroinvertebrates found are listed in Table 1. Station 1M is the sample taken from the middle and 1S is the sample taken near the south bank of the river at station 1 and so forth. The number of organisms per square meter was calculated by multiplying the number of organisms counted by 38.34. At all the stations tubificids were the most common organisms collected with <u>Limnodrilus</u> <u>hoffmeisteri</u> found at every station. The second most common group in stations 1 and 2 were the Pelecypoda, but these and the Gastropoda were not found further upstream. At stations 3, 4 and 5 the Chironomidae were the second most abundant group.

The data from Table 1 is summarized in Table 2. The bottom type for all stations was similar except stations 3S and 5M. Station 3S bottom type was an oily muck in which a very small number of organisms were found. All were tubificids and only one was identified to be a Limnodrilus hoffmeisteri. Station 5M bottom was very gravelly, which prevented the Ponar grab from closing. The best grab kept for the survey was not full.

The number of taxa found in the shore samples was generally greater than the midstream sample for each station.

The Shannon-Weiner H' diversity index (Fager, 1972; as cited by Bergantz, 1977) and the Equitability were calculated using the following formulas:

$$H' = \sum_{i=1}^{S} p_i \ln p_i \qquad p_i = n_i / N$$

S = no. of species

$$H_{max} = \ln S$$

n_i = no. organisms in the i^{th} species

$$\text{Equitability} = H' / H_{max}$$

N = no. of organisms

The diversity index is a number that takes into account both species richness and equitability. For this calculation the number of immature Tubificidae with and without hair chaetae were split proportionally and added to the number of the identified Tubificidae. For example, at station 2M, since there was only one specie of Tubificidae without hair chaetae identified, all the immature without hair chaetae were considered to be Limnodrilus hoffmeisteri. Since there were no mature Tubificids with hair chaetae identified, the immature Tubificids with hair chaetae were considered one specie.

The highest H', at station 3M, was due to a high equitability, whereas the second highest H', at station 1S, was due to the highest number of taxa found there. Stations 2M and 2S have low H' despite a relatively large number of taxa because most of the organisms counted were considered one specie.

The percent Tubificidae ranged from 91% to 100% for all stations. A high % of Tubificids indicates a high degree of organic pollution (Goodnight and Whitley, 1961: as cited in Bergantz, 1977).

A comparison was made with a survey done by Bergantz (1977). Comparisons were made between 2 sites that were at similar locations for both surveys. Table 3 shows how the samples compared. The taxa collected were similar but Bergantz had a higher number of taxa. Two differences in the survey methods may account for this discrepancy. The Bergantz survey was collected in November while the 1988 survey was collected in July. The Bergantz survey is an average of two Ponar grabs per station while only one grab was taken at each station in the 1988 survey.

Finally, a comparison was made between the 1988 survey and a survey done by the DEC using a multiplate sampler (Table 4). Because the method of sampling was different, only a comparison of organisms could be made, and none of the taxa matched. The taxa collected with the Ponar grab were predominantly Oligochaetae and the taxa collected with the multiplate sampler were predominantly Chironomidae.

TABLE 1

BENTHIC MACROINVERTEBRATES ORGANISMS/SQUARE METER

MACROINVERTEBRATES	1 M	1 S	2 M	2 S
ANNELIDA				
Oligochaeta				
Tubificidae				
Immature Tubificidae w/o hair chaetae	19822	40825	62533	61919
Immature Tubificidae with hair chaetae	575	192	2645	2760
Limnodrilus cervix	5636	575	0	0
Limnodrilus hoffmeisteri	2952	1112	7975	8243
Limnodrilus claparedianus	613	192	0	0
Limnodrilus udekemianus	0	0	0	0
Potamothrix vejdovskyi	0	0	0	0
Tubifex tubifex	0	0	0	0
Quistadrilus multisetosus	0	0	0	2760
Aulodrilus pluriseta	0	0	0	0
Polychaetae				
Manayunkia speciosa	0	230	0	0
Hirudinea	38			
Helobdella stagnalis	38	0	77	422
TURBELLARIA	0	230	0	38
ISOPODA				
Asellus sp.	0	38	77	115
DIPTERA				
Chironomidae				
Tanypodinae				
Procladius sp.	38	230	115	460
Chironominae				
Tribe Chironomini				
Chironomus sp.	38	0	0	690
Polypedilum sp.	0	0	0	0
Glyptotendipes sp.	0	0	0	0
Tribe Tanytarsini	0	0	0	38
Culicidae				
Chaoborus sp.	0	0	0	0
TRICHOPTERA				
Leptoceridae	0	38	0	0
GASTROPODA				
Valvatidae				
Valvata sincera	0	345	307	153
Valvata piscinalis	0	38	0	0
Hydrobiidae				
Bithynia tentaculata	0	0	0	115
PELECYPODA				
Sphaeriidae				
Sphaerium sp.	0	0	230	192
Sphaerium transversum	77	422	192	38
Pisidium sp.	268	1265	2109	2262
Unionidae	0	38	0	0
TOTAL ORGANISMS	30095	45770	76260	80205

3 M	3 S	4 M	4 S	5 M	5 S
27260	422	20780	23711	7821	5904
4409	0	460	0	537	383
0	0	959	2569	0	153
1495	38	3297	5138	192	268
3681	0	498	0	0	0
728	0	0	0	0	0
728	0	0	0	0	0
1495	0	959	1304	0	0
0	0	0	0	0	0
0	0	0	652	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
			38		
0	0	307	1150	383	383
0	0	0	230	0	0
38	0	0	0	38	268
0	0	0	38	0	0
0	0	0	0	0	0
38	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
39872	460	27260	34830	8971	7359

TABLE 2

SUMMARY OF THE BENTHIC MACROINVERTEBRATES DATA (TABLE 1)

STATION	BOTTOM TYPE	DEPTH (m)	RICHNESS (taxa)	SHANNON-WEINER H'	EQUIT-ABILITY	% TUBIF.
1M	SILT, SAND, SHELL PARTS, DETRITUS	9.1	10	1.016	.441	98
1S	SILT, SAND, SHELL PARTS, DETRITUS	2.0	14	1.217	.461	94
2M	SILT, SHELL PARTS, DETRITUS	7.7	9	.368	.168	96
2S	SAND, SHELL PARTS, DETRITUS	3.7	13	.557	.217	94
3M	SILT, DETRITUS, SHELL PARTS	8.2	7	1.318	.677	99
3S	OILY MUCK, GRAVEL, DETRITUS	2.0	1	0	–	100
4M	SILT, DETRITUS	7.1	5	1.027	.638	99
4S	SILT, DETRITUS	2.0	8	1.024	.439	96
5M	GRAVEL, SILT, DETRITUS	3.6	4	.428	.308	95
5S	DETRITUS, SILT	2.0	5	1.122	.697	91

TABLE 3

COMPARISON WITH BERGANTZ BENTHIC SURVEY IN 1977
ORGANISMS/SQUARE METER

MACROINVERTEBRATES	1988 4 M	BERGANTZ STATION 2	1988 5 M	BERGANTZ STATION 3
ANNELIDA				
Oligochaeta				
Tubificidae				
Immature Tubificidae w/o hair chaetae	20780	23020	7821	11028
Immature Tubificidae with hair chaetae	460	491	537	28
Limnodrilus sp.	0	491	0	350
Limnodrilus cervix	959	1285	0	1683
Limnodrilus hoffmeisteri	3297	1058	192	1162
Limnodrilus claparedianus	498	0	0	1021
Limnodrilus udekemianus	0	5387	0	491
Tubifex tubifex	959	198	0	0
EPHEMEROPTERA	0	0	0	9
DIPTERA				
Chironomidae				
Tanypodinae				
Procladius sp.	307	66	383	28
Chironominae				
Tribe Chironomini				
Chironomus sp.	0	19	0	9
Polypedilum sp.	0	0	38	0
Tribe tanytarsini	0	9	0	0
TOTAL ORGANISMS	27260	32026	8971	15810
TOTAL NO. TAXA	5	8	4	9
SHANNON-WEINER H'	1.027	1.048	.428	1.562
EQUITABILITY	.638	.325	.308	.802
% TUBIFICIDAE	99	99	95	99

TABLE 4

COMPARISON WITH DEC SURVEY OF 1987

MACROINVERTEBRATES	1988 3 M	DEC 7/87 DATA STATION 7
ANNELIDA		
Oligochaeta		
Tubificidae		
Immature Tubificidae w/o hair chaetae	X	-
Immature Tubificidae with hair chaetae	X	-
Limnodrilus hoffmeisteri	X	-
Limnodrilus claparedianus	X	-
Limnodrilus udekemianus	X	-
Potamothrix vejdovskyi	X	-
Tubifex tubifex	X	-
Naididae		
Nais variabilis	-	X
Stylaria lacustris	-	X
AMPHIPODA		
Gammaridae		
Gammarus fasciatus	-	X
DIPTERA		
Chironomidae		
Tanypodinae		
Ablabesmyia monilis	-	X
Conchapelopia sp.	-	X
Orthocladiinae		
Nanocladius distinctus	-	X
Chironominae		
Chironomini		
Dicrotendipes lucifer	-	X
Dicrotendipes simpsoni	-	X
Glyptotendipes lobiferus	-	X
Parachironomus abortivus	-	X
Polypedilum convictum	-	X
Polypedilum sp.	X	-
CULICIDAE		
Chaoborus sp.	X	-
TOTAL NO. OF TAXA	7	11

DISCUSSION

Blum reported finding no benthic macroinvertebrates in the Buffalo River dredged section in 1963 and 1964 (Bergantz, 1977). By 1970, the Great Lakes Lab reported Oligochaetae at almost all sampling stations (Bergantz, 1977). Up to 1977 thé benthic fauna have been increasing in number of taxa and number of organisms. But the 1988 survey showed no improvement from the 1977 survey.

The presence of the Polychaete, Manayunkia speciosa, was not recorded in previous surveys but is not necessarily an indication of improvement. Those found in this survey were at station 1S, the mouth of the river. Manayunkia speciosa seems to have a wide range of tolerance to some environmental parameters, such as pH, depth, DO content and temperature, and occurs frequently at the mouths of streams (Poe and Stefan, 1974).

In looking at the middle and shore samples, generally, a larger number of taxa was found in the shore sample. This could be due to substrate disturbance in the middle by the dredging of the river every year. Besides dredging up the benthic organisms, the natural vegetation is destroyed. It has been shown that many aquatic species prefer a vegetated bottom (Snyder, 1976). More than a year may be required for recolonization of aquatic plants.

Dredging may also explain why some species were not found at stations 3, 4 and 5. The Hirudinae require a substrate to which they can adhere and therefore are uncommon on the pure mud or clay bottom (Pennak, 1978), found in the river.

The Gastropoda and Pelecypoda were also not collected above station 2 (Table 1). The only factor that seems to limit snail distribution is a low concentration of oxygen, but also the presence of vascular aquatic plants has a positive correlation with a dense and diverse snail population (Harman and Berg, 1971). Bare rock bottoms and shifting sand and mud are unsuitable for bivalves (Clarke and Berg, 1959; Pennak, 1978). Mussels are also killed quickly by a decrease in oxygen resulting from organic pollution (Clarke and Berg,1959).

The Shannon-Weiner diversity index (H') did not show any pattern from station to station and could be deceiving without looking at the richness and equitability at each station. The index is based solely in information on community structure and does not reflect any knowledge of the physiological attributes or ecological affinities of the organisms comprising the community (Howmiller and Scott, 1976).

The use of the % Tubificidae (Tables 2 & 3) as a bioindicator also has its shortcomings. First, the category of organisms considered may contain many organisms which are physiologically different and will respond differently to a given environment (Howmiller and Scott, 1976). Species tolerant of pollution may be found in both clean and degraded habitats. The presence or absence of a particular taxa may depend more on characteristics of the environment, such as velocity and substrate, than on the level of degradation by organic wastes (Weber, 1973).

As shown by table 4, sampling method used has a great effect on the results and should be carefully considered when choosing a sampling device. The advantages of the multiplate sampler are: it provides a standard substrate, quantitative comparable data can be obtained in environments where it is impossible to get a Ponar grab sample, and samples contain negligible amounts of extraneous material, permitting quicker laboratory processing (Weber, 1973). Disadvantages of the multiplate are: the sample provides no measure of conditions of the natural substrate, it is selective of certain types of fauna, and samples only record the community that develops during the sampling period thus reducing the value of collected fauna as indicators of prior conditions (Weber, 1973).

The Ponar grab may give an indication of fauna actually found on the bottom at the station, but it is an imprecise estimate of the number of organisms. It also indicates the composition of the substrate. The Ponar grab cannot be used on hard substrates or in a high flow current.

The DEC uses the multiplate sampler in a Statewide survey of streams and rivers, therefore the advantages of the multiplate sampler outweigh the disadvantages.

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