ENVIRONMENTAL PROTECTION BRANCH
ENVIRONMENTAL PROTECTION SERVICE
PACIFIC REGION

WATER QUALITY AND MACROINVERTEBRATE COMMUNITY STRUCTURE OF BESSETTE CREEK, B.C.: AN INTERIOR STREAM ADJACENT TO A SEWAGE LAGOON

Regional Program Report No. 80-1A

by

G. Derksen

March 1980

ABSTRACT

Generally, the water quality of Bessette Creek in the immediate vicinity of the Lumby sewage lagoon was not found to differ from that upstream. However, exfiltration from the sewage lagoon was evident as indicated by increased levels of ammonia during reduced streamflows.

Both multiple plate and modified Hess circular sample methods indicated the macroinvertebrate community structure of Bessette Creek to be indicative of a clean waterstream. The macroinvertebrate community structure at stations 1 to 5 was similar and any major impact due to a lagoon discharge should be detectable.

RÉSUMÉ

En général, la qualité des eaux du ruisseau Bessette, à proximité du bassin de stabilisation des eaux usées de Lumby, n'est pas différente de celle des eaux situées en amont. Toutefois, les teneurs plus élevées en ammoniaque, relevées en périodes de débit plus faible, indiquent une certaine déperdition des eaux du bassin.

L'étude de la composition des populations de macro-invertébrés du ruisseau Bessette, effectuée à l'aide d'un échantillonneur à plaques multiples et d'un échantillonneur Hess modifié à cadre circulaire, révèle que les eaux de ce ruisseau sont propres. À chacune des 5 stations échantillonnées, les populations étaient semblables et toute incidence majeure d'un rejet provenant du bassin de stabilisation aurait dû être décelable.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY AND CONCLUSIONS

Evidence of exfiltration from the sewage lagoon was detected on three occassions when ammonia levels were appreciably greater than background levels. The increased concentrations were evident during reduced flow conditions. Water hardness and total inorganic carbon were slightly higher at station 6, likely due to the influence of Vance Creek.

The Shannon and Weaver macroinvertebrate diversity index was generally greater than 3, except for October 1975, when values of less than 1 were detected at stations 1 to 5 inclusive. Diversity index values between 3-4 are indicative of clean water streams. The reduced diversity in October is attributed to the hatching of a large number of chironomidae in that reach of the creek. At that time station 6 had a diversity of 2.87 indicating a different macroinvertebrate community structure. Stations 1 to 5 inclusive were similar with respect to macroinvertebrate community structure and major changes resulting from the sewage lagoon discharge should be detectable.

Multiple plate sample methods proved effective in the collection of macroinvertebrates during periods when water depth and flows prohibit natural substrate collection methods.

Bank stabilization work was carried out along the sewage lagoon's creek edge in July 1975, and it is speculated an impact may have been detectable .5 km downstream as evidenced by a reduction in density of organisms.

A follow-up survey should be conducted when a point source discharge occurs after the lagoons have sealed.

1 INTRODUCTION

The British Columbia Pollution Control permit issued to the Village of Lumby in 1967, authorized the discharge of an average of 685 m^3/day of treated sewage effluent from April 15 to June 14 into Bessette Creek at a rate not to exceed a minimum dilution of 20:1 ... in cases of emergency, a limited discharge would be allowed from October 16 to April 15 ... subject to a minimum dilution of 20:1. An amendment was added in 1973, to provide for chlorination prior to discharge of Bessette Creek.

The Department of Fisheries and Environment, Fisheries and Marine Service report that Bessette Creek is probably the most important salmon tributary of the Shuswap River. An average of 1000-2500 coho spawn in it yearly, and a large number of these spawn in the vicinity of the proposed outfall. In addition, spawning records indicate that in the area of the outfall 25-75 chinook salmon spawn each year. Important coho salmon and trout rearing areas exist near the outfall and throughout sections of the entire system.

The toxic nature of chlorinated sewage has been demonstrated on salmon (Buckley, 1976; Buckley et al, 1976; Martens and Servizi, 1974, Servizi and Martens, 1974, Mattice and Zittel, 1976) and on invertebrate animals (Mattice and Zittel, 1976; Dickson et al, 1977). Considering the toxic nature of chlorinated sewage and that the commencement of discharge was indefinite pending the lagoons filling, the Environmental Protection Service in consultation with the Pollution Control Branch initiated a predischarge study in 1975 to assess the macroinvertebrate community structure and the chemical/physical water quality of Bessette Creek.

Samples were collected in the early summer of 1975, the fall of 1975 and the spring of 1976. To assess the macroinvertebrate community structure during freshet conditions, Hester-Dendy multiple plate samplers were used (Hester and Dendy, 1962).

In addition, on two occassions a modified Hess circular sampler (Hess, 1941) was used so a comparison between natural substrate and artificial substrate collections could be made. This report presents an assessment of community structure based primarily on the multiple plate sampler with some comparisons drawn between the two methods.

2 DESCRIPTION OF STUDY AREA

Bessette Creek is located in the central interior of British Columbia, 24 km east of the City of Vernon (Figure 1). Bessette Creek flows through the eastern periphery of Lumby Village limits and the Lumby sewage lagoon lies immediately adjacent to the creek (Figure 2). The sewage lagoon was completed towards the end of 1974 and is comprised of a complete mix and aeration cell followed by two polishing cells and a chlorine contact chamber. During the period of study the #1 polishing cell was only partially filled and this remained unchanged through June 1975 - June 1976, likely due to exfiltration and evaporation processes.

Five sample stations were established; a control immediately upstream of the lagoon (Station #1), one 10 meters upstream of the proposed outfall (Station #3), one 10 meters downstream of the proposed outfall (Station #4), one 0.5 km downstream of the proposed outfall (Station #5) and at a site 6.5 km downstream (Station #6, Figure 1). A description of the sample locations are given in Appendix I.

Spring freshet on Bessette Creek generally occurs between the months of May and June (Figure 3) and flows as high as 34 m^3/s have been reported. During that period water depth in the riffle areas studied is in the order of 1.5 meters. In the autumn, water levels in the same areas can be less than .15 meters and flows as low as 0.3 m^3/s occur.

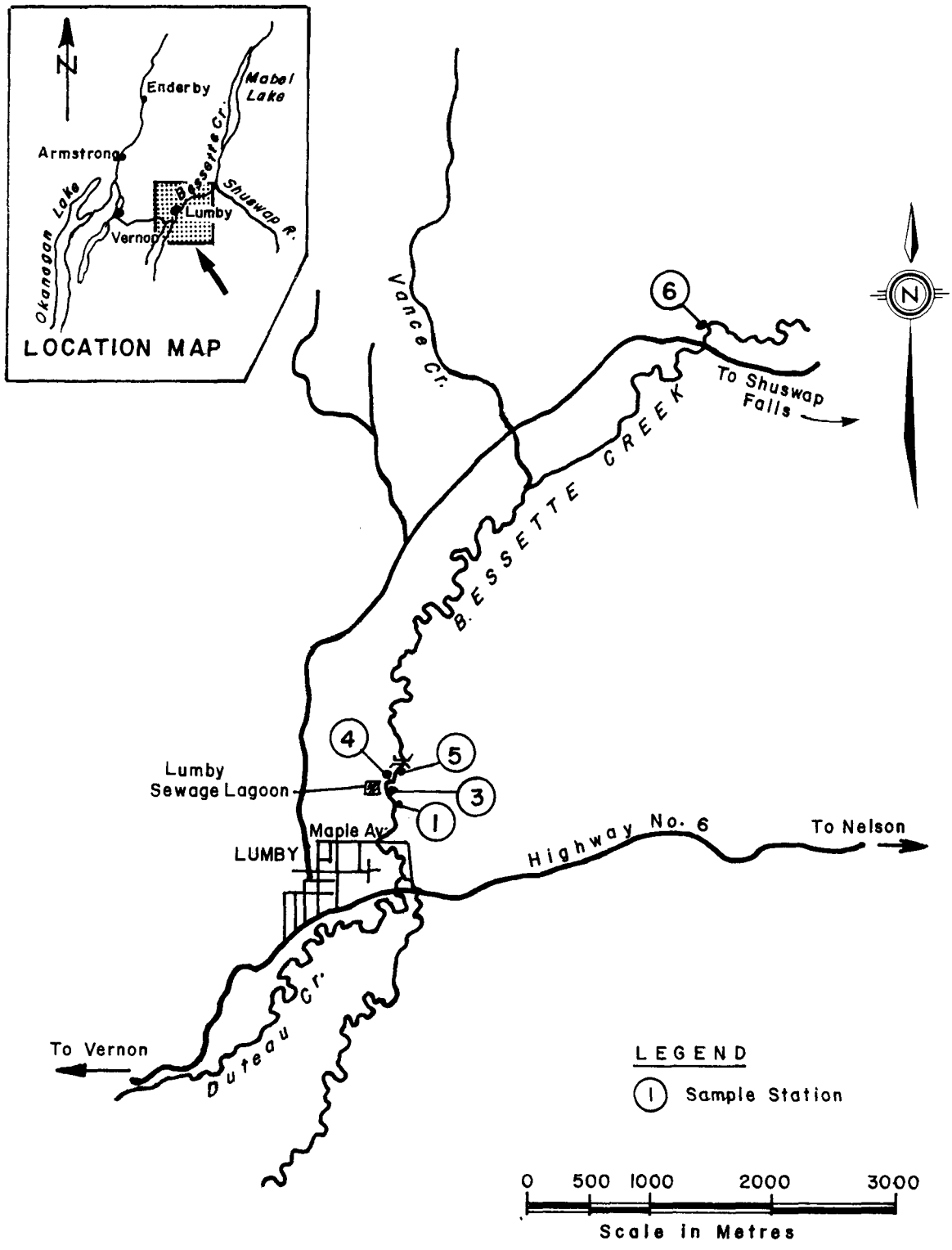

FIGURE 1 BESSETTE CREEK SAMPLE STATION LOCATIONS

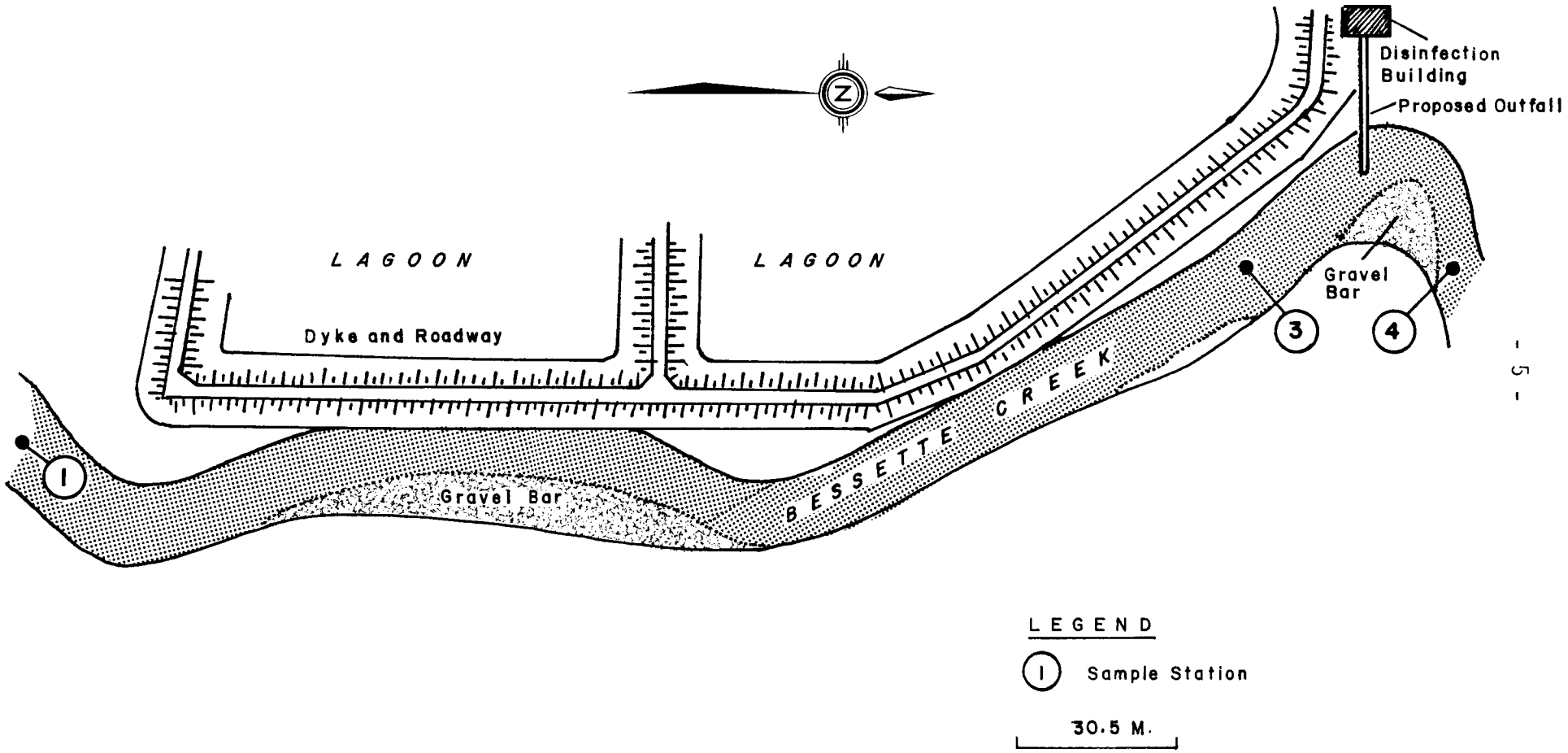

FIGURE 2 BANK PROTECTION - LUMBY SEWAGE LAGOONS

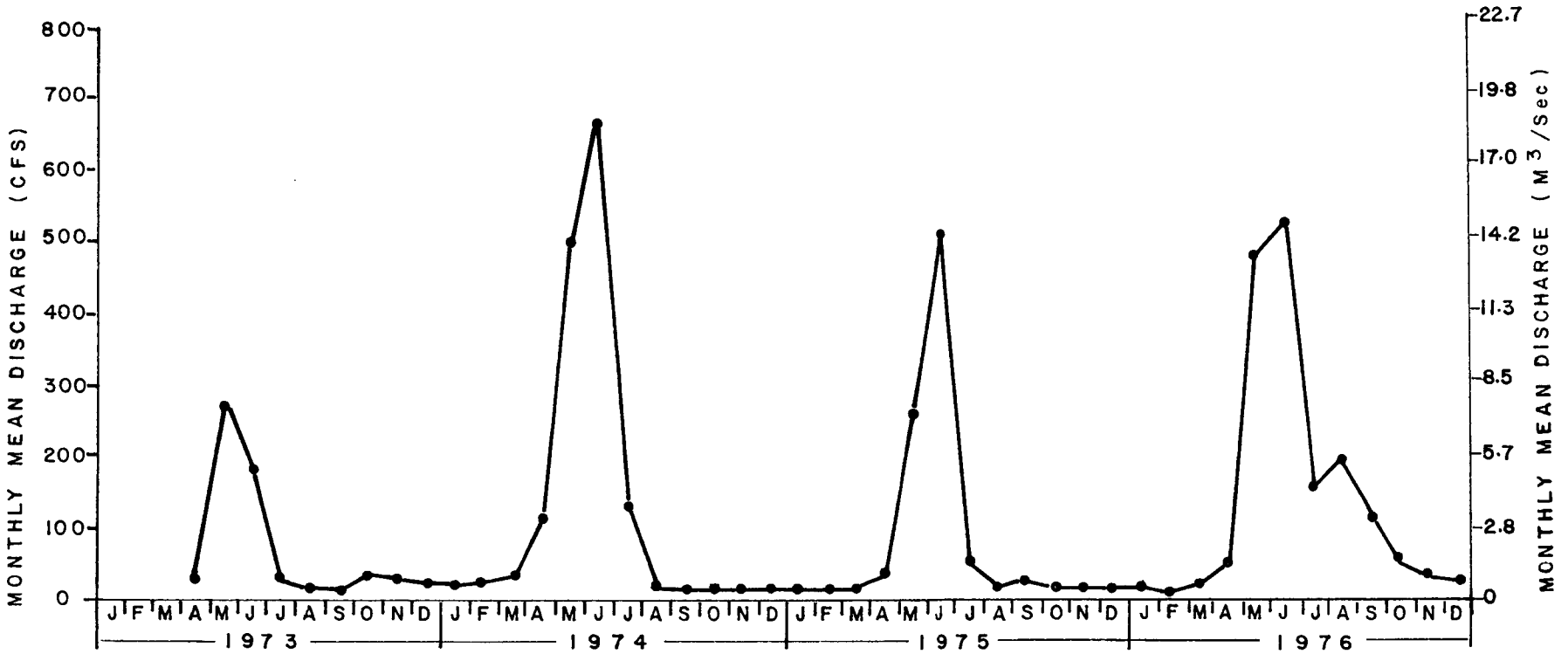

FIGURE 3 MONTHLY MEAN FLOW FOR BESSETTE CREEK AT WATER SURVEY OF CANADA STATION 08LC042

3 METHODS AND MATERIALS

3.1 Water Chemistry

All water samples were collected with a 3 litre Van Dorn bottle. Water samples for dissolved oxygen were transferred to 300 ml BOD bottles, preserved immediately with manganese sulfate and alkali-iodide-azide reagents and titrated against a .025 N sodium thiosulphate solution within 12 hours. The samples for total organic and inorganic carbon were stored in a 100 ml polyethylene sample bottle. Two separate untreated samples, one for turbidity, conductivity, hardness and pH, and a second for nitrate-nitrogen, total ammonia-nitrogen and total phosphate were stored in 500 ml polyethylene sample bottles. Samples for total dissolved phosphate were immediately filtered through a distilled water-washed 0.45 micron cellulose acetate membrane filter and stored in a 125 ml polyethylene sample bottle. All samples were kept cool with wet ice, and returned to the Environment Canada, Environmental Protection Service - Fisheries Service, Cypress Creek Laboratory, West Vancouver within 16 hours. Samples were analysed utilizing the methods outlined in the Pollution Sampling Handbook of the Environmental Protection Service of Environment Canada (Anonymous, 1976). Temperature was recorded with a standard hand- held thermometer.

3.2 Macroinvertebrates

Five multiple plate samplers (0.1 m^2 each) were installed at each station and allowed to colonize for approximately four weeks. Each sampler was suspended from a two meter piece of 1.3 cm diameter reinforcing steel bar, driven into the creek bed. A 454 gram piece of fisherman's pencil lead was strung on the sampler line (2.38 mm diameter stainless steel cable) to aid in submersion and the samplers were suspended in the water column and adjusted on the bar so that during low flows they would be suspended just above the creek bottom. Upon collection and so as to prevent escapement each sampler was quickly and carefully placed in a one gallon container. The sampler was dismantled

in the container, each plate carefully brushed with a soft toothbrush, washed in a 354 micron mesh sieve, and preserved with a solution of 10 percent formaldehyde until sorted, identified and enumerated.

For comparative purposes, on two occassions, three samples of macroinvertebrates were collected at each station using a (0.093 m^2) modified circular sampler with a 351 micron Nitex cloth (Hess, 1941, Waters and Knapp, 1961). The samples were treated in the same manner as the multiple plate samples.

A wild M5 stereo microscope and a M11 compound microscope were used for identification purposes along with the biological keys of Pennak (1953), Ward and Whipple (1959) and Usinger (1968).

3.2.1 Data Handling and Presentation. For the purpose of this study the term "taxa" denotes that macroinvertebrates have been identified to the taxonomic level of family or the lowest identifiable level above family. Detailed analyses for the multiple plate samplers are reported in Appendix II and circular sampler data is available on request from the author.

Community structure was determined using the Shannon and Weaver (1963) formula for diversity $H'(d) = -\sum pi \log_2 pi$ ($pi = ni/N$, ni = the number of individuals in the i species, N = the total number of individuals sampled) as described by Pielou (1966) and Wilhm and Dorris, (1968). Eveness with which the individuals are divided among the taxa was determined using the formula $J = -\sum \frac{pi \log 2pi}{\log_2 S}$ (s = the total number of species sampled, J max = 1) as described by Pielou (1966).

The percent distribution of organisms (by order), mean number of organisms per square meter and total number of taxa (by family) were determined for each composite sample (total of all plates recovered per station).

Data analysis and computations were performed on a Hewlett-Packard Model 9830A computer.

4 RESULTS AND DISCUSSION

4.1 Water Chemistry

Temperature, pH, dissolved oxygen, percent saturation, turbidity and hardness are presented in Table 1 while total phosphate (TPO_4), total dissolved phosphate, total organic carbon (TOC), total inorganic carbon (TIC), nitrate nitrogen (NO_3-N) and total ammonia nitrogen ($NH_3 + NH_4^+$) are presented in Table 2. The monthly mean flows for Bessette Creek between 1973-1976 are shown in Figure 3 (Water Survey of Canada, 1974-1977).

Temperature ranged between 4.5-18.5°C for the period samples were collected, dissolved oxygen between 8.1-14.3 mg/l, percent saturation between 83.3 and 141.9%, and pH between 7.3-8.6. These values are consistent with those recommended for the protection of freshwater streams (Water Quality Criteria, 1972, and McKee and Wolf, 1963). There was no evidence of the lagoon having any appreciable affect on Bessette Creek with respect to the above parameters.

Turbidity ranged between high values of 21-39 JTU's during freshet periods (May-June) to lows of approximately 3.0 JTU's during summer and autumn. Turbidity values in the range of 200 units are generally reported as having no harmful effects on fish (McKee and Wolfe, 1963). On the three occassions water hardness was measured, hardness ranged between 20-170 mg/l which is indicative of soft to moderately soft water. There was no evidence of the lagoon having any appreciable affect on Bessette Creek with regards to turbidity and hardness.

Sewage effluent contains nitrogen, phosphorous and carbon, each of which are associated with the eutrophication of lakes and streams. Nitrogen in the form of NO_3 is completely free to move through the soil unless intercepted by plants. While nitrogen in the form of NH_3 may be adsorbed for a short period in soils through exchange phenomena, it is eventually nitrified to NO_3-N and becomes highly mobile (Oldham, 1975). Nitrogen in the soil can be removed through plant uptake, soil storage, de-nitrification, volatization and leaching to ground water or surface water. Phosphorous in sewage effluent is

TABLE 1 WATER CHEMISTRY - PHYSICAL DATA FOR BESSETTE CREEK

Sample Date	June 4, 1975					July 2, 1975				
Station	1	3	4	5	6	1	3	4	5	6
Parameter										
pH	7.5	7.3	7.3	7.4	7.6	7.8	7.9	7.7	7.7	8.0
Dissolved Oxygen (mg/l)	11.0	10.8	10.7	10.6	10.5	8.2	8.1	8.2	8.8	8.6
Percentage Sat. (%)	93.5	91.8	91.0	90.1	90.3	90.1	89.0	90.1	96.7	92.7
Temperature (°C)	7.0	7.0	7.0	7.0	7.5	18.5	18.5	18.5	18.5	17.5
Conductivity	-	-	-	-	-	-	-	-	-	-
Turbidity (JTU's)	34	23	21	28	37	3.1	3.4	3.2	3.3	5.3
Hardness (mg/l)	22	23	23	20	33	38	40	26	46	66

	July 30, 1975					September 24, 1975				
	1	3	4	5	6	1	3	4	5	6
pH	8.3	8.2	8.1	8.0	8.2	8.6	8.4	8.6	8.1	8.1
Dissolved Oxygen (mg/l)	11.0	10.9	10.1	10.3	10.8	13.3	13.7	14.3	11.1	10.4
Percentage Sat. (%)	119.7	117.5	108.8	106.6	105.9	132.0	131.3	141.9	100.6	93.5
Temperature (°C)	18.0	17.5	17.5	15.5	13.0	13.5	12.0	13.5	9.5	9.2
Conductivity	-	-	-	-	-	-	-	-	-	-
Turbidity (JTU's)	3.4	3.7	5.4	3.5	3.7	2.8	2.7	2.8	3.0	2.4
Hardness (mg/l)	140	150	140	140	170	-	-	-	-	-

..... cont'd.

TABLE 1 WATER CHEMISTRY - PHYSICAL DATA FOR BESSETTE CREEK (Continued)

Sample Date	October 21, 1975					April 20, 1976				
Station / Parameter	1	3	4	5	6	1	3	4	5	6
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.1
Dissolved Oxygen (mg/l)	11.6	11.4	10.7	10.3	11.2	10.9	10.7	10.9	10.7	11.3
Percentage Sat. (%)	93.6	92.2	86.6	83.3	89.3	95.7	94.0	95.7	94.0	98.0
Temperature (°C)	5	5	5	5	4.5	8.3	8.3	8.3	8.3	7.8
Conductivity	-	-	-	-	-	-	-	-	-	-
Turbidity (JTU's)	3.0	3.0	3.0	3.0	4.0	6.0	7.0	6.0	6.0	7.0
Hardness (mg/l)	-	-	-	-	-	-	-	-	-	-
	May 18, 1976					June 24, 1976				
	1	3	4	5	6	1	3	4	5	6
pH	7.4	7.4	7.4	7.4	7.7	7.5	7.5	7.5	7.5	7.7
Dissolved Oxygen (mg/l)	10.4	10.4	10.4	10.4	10.7	10.0	10.0	10.2	10.1	10.1
Percentage Sat. (%)	90.6	90.6	90.6	90.6	92.8	87.6	87.6	89.3	88.5	88.5
Temperature (°C)	8.0	8.0	8.0	8.0	7.8	8.2	8.2	8.2	8.2	8.2
Conductivity	-	-	-	-	-	-	-	-	-	-
Turbidity (JTU's)	29	32	30	31	39	18	18	14	15	21
Hardness (mg/l)	-	-	-	-	-	-	-	-	-	-

TABLE 2 WATER CHEMISTRY - BIONUTRIENT DATA FOR BESSETTE CREEK

Sample Date	June 4, 1975					July 2, 1975					July 30, 1975					September 24, 1975				
Station	1	3	4	5	6	1	3	4	5	6	1	3	4	5	6	1	3	4	5	6
Parameter*																				
TIC	4	4	4	4	6	9	9	9	9	14	24	25	25	25	32	28	28	27	29	33
TOC	14	13	13	13	13	8	8	8	8	7	5	5	5	5	3	3	3	4	4	4
NO_3-N	.011	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.010	<.01	<.01	<.01	<.01	<.01	.010	.010	<.01	<.01	.010
NH_3-N	.01	.01	.01	.01	.01	.014	.018	.007	.009	.005	.007	.066	.029	.027	.007	.005	.006	.005	.005	.005
TPD4-P	.190	.220	.180	.140	.210	.030	.020	.020	.020	.030	.030	.040	.040	.030	.020	.020	.030	.030	.030	.020
TDPO4-P	.015	.013	.014	.019	.011	.010	.010	.010	.010	.010	.020	.030	.030	.020	.010	.020	.020	.020	.020	.010

	October 21, 1975					April 29, 1976					May 18, 1976					June 24, 1976				
	1	3	4	5	6	1	3	4	5	6	1	3	4	5	6	1	3	4	5	6
TIC	34	34	34	34	37	21	21	21	21	27	6	6	6	6	10	6	6	6	7	7
TOC	3	7	3	3	3	11	10	9	10	9	14	14	14	14	13	11	11	11	11	11
NO_3-N	.020	.030	.030	.030	.060	.120	.120	.120	.120	.150	.010	.010	.010	.010	.010	.013	.019	.010	<.01	.016
NH_3-N	.005	.030	.030	.020	.005	.015	.035	.028	.032	.110	.013	.016	.016	.016	.019	.010	.015	.010	.008	.009
TPO4-P	.020	.030	.030	.030	.020	.060	.050	.054	.058	.100	.160	.180	.160	.150	.150	.078	.017	.063	.071	.091
TDPO4-P	.010	.020	.020	.020	.010	.028	.020	.032	.034	.049	.016	.017	.017	.014	.023	.015	.017	.016	.016	.015

* as mg/l

primarily in the form of dissolved ortho-phosphate which is the form that can be absorbed directly by algal cells. Phosphorous is readily adsorbed to surface particles of soil (provided it is not previously saturated) and is not generally made available again by biological means, thus the likelihood of groundwater contamination with phosphorous is not as great as with nitrogen.

While the number of data points is not large some general observations can be made with respect to nutrients. Nitrate concentrations generally ranged between <10 - 30 ug/l but in April 1976, values of 120 - 150 ug/l were recorded throughout the study area. Ammonia concentrations generally ranged between <5-18 ug/l but on three occassions higher concentrations indicated the likelyhood of exfiltration from the sewage lagoon. On July 30, 1975 and October 21, 1975 (flows .34 and .40 m3/s respectively) stations 1 and 6 reported values of < 5 - 7 ug/l while stations 3, 4, and 5 had values ranging from between 20 - 66 ug/l. On April 29, 1976 (flow 1.61 m3/s) station 1 reported a value of 15 ug/l compared to a range of 28-35 ug/l at stations 3, 4 and 5.

Total phosphate values were highest during freshet when turbidity was greatest and phosphate concentrations ranged between 63 - 180 ug/l. During reduced flows total phosphorous values of 20 - 40 ug/l were the norm. Irrespective of the increased sediment load of the creek during freshet total dissolved phosphate concentrations remained quite consistent throughout the study area at 10 - 30 ug/l. Phosphate concentrations did not appear to indicate the presence of the sewage lagoon.

The respective large increases of NO_3-N, NH_3-N, TPO_4-P and $TDPO_4$-P at station 6 on April 20, 1976 could be the result of manure disposal practices at a farm located upstream. Due to an unusually wet year, water was observed to be sitting in areas of manure storage which were close to the creek edge. Filip and Middlebrooks, 1976, found cattle waste runoff to be extremely rich in nutrients and in stimulating algal growth. They also reported that at more concentrated levels biostimulation was inhibited by toxicity.

Total inorganic carbon concentrations were generally lowest during freshet periods (6 - 10 mg/l) and highest during reduced flows (24 - 37 mg/l). Total organic carbon showed the inverse condition with high values of 8 - 14 mg/l during high flows and 3 - 5 mg/l during reduced flows.

The water quality of station 6 was slightly dissimilar to that of the other stations sampled. Water hardness and TIC were slightly greater at station 6, likely a result of the influence of Vance Creek.

4.2 Macroinvertebrates

The use of macroinvertebrates as indicators to reflect enviromental quality and benthic community structure as it relates to pollution are well documented: Cairns and Dickson, 1971; Goodnight, 1973; Wilhm and Dorris, 1968, and Whitton, 1975. The biology of benthic invertebrates has been reviewed by Hynes, 1970 and Whitton, 1975 and distribution mechanisms by Waters, 1972, Williams and Hynes, 1976 and Peckarsky, 1979.

Resh and Unzicker, 1975 in reviewing the importance of species identification in designating invertebrates with respect to pollution tolerance identified the difficulties of identifying immature stages below the generic level and establishing ecological tolerances for each individual species. The above feel it is futile to attempt to develop water quality criteria by using indicator organisms that have been identified only to the generic level. Still, certain guidelines for grouping invertebrates with respect to pollution sensitivity are commonly used (Servizi and Burkhalter, 1970; Cairns and Dickson, 1971; Whitton, 1975). Immature or larval stages of Ephemeroptera (mayfly), Plecoptera (stonefly), Coleoptera (beetle) and Trichoptera (caddisfly) are generally grouped as pollution sensitive. Moderately sensitive groups include Diptera (two-winged fly), Gastropoda (snails), Hemiptera (waterbugs), some midge larvae and dragonfly nymphs. Pollution tolerant organisms generally include Tubificidae worms, leeches and some midge larvae (bloodworms).

Wilhm, 1970, described diversity as varying between 3 - 4 in clean water streams and is usually less than one in polluted streams. Eveness ranges between 0 - 1 with higher values representing a more even distribution of organisms among the taxa identified. Hughes, 1975, has shown diversity varies with the type of sampler used and Hughes, 1978, studied factors influencing the Shannon diversity index. Hughes, 1978, found that with Surber samples, diversity progressively increased until four samples were pooled and additional samples produced little change. He also found diversity varied seasonally and that diversity values increase progressively with the taxonomic level from order to species but the same patterns are detectable at the order level.

On three of the four sample periods multiple plates were set out the diversity and eveness of macroinvertebrates in Bessette Creek were indicative of a clean water stream. For these three periods the overall mean stream diversity ranged between 2.56 - 3.66 for an overall mean of 3.17 (Table 3, Figure 4). An exception to this trend was observed in October 1975, when very low diversities and eveness were reported for stations 1 to 5 (diversity = .54 - 1.02, J = .15 - .23, respectively) (Figure 4). The reduced diversity is a result of a large number of chironomidae sampled in the stretch of creek between station 1 and 5 (Figures 5 and 6). The significance of this is not so much that the diversity is low but that it indicates the creek between station 1 and 5 has a similar community structure and any impact due to a lagoon discharge should be detectable. Station 6 was exceptional for this period in that diversity and eveness were 2.87 and .66 respectively.

Dills and Rogers, 1974, found that species diversity values in polluted streams (acid mine pollution) showed no seasonal response, while the unpolluted stations showed a definite seasonal response. The non-polluted stations had values generally ranging between 2.5 - 4.0 except for the late summer - early autumn period when values of less than two were recorded. Dills and Rogers, 1974, attributed the autumn low macroinvertebrate diversity to the hatching of eggs of those species that grow during the winter. Rosenberg and Wiens, 1978, indicated that

TABLE 3 DIVERSITY AND EVENESS OF MACROINVERTEBRATE SAMPLES FROM BESSETTE CREEK

Date:	July 3, 1975				July 30, 1975				September 24, 1975				October 21, 1975				May 18, 1976			
Sampler:	MP		CS		MP		CS		MP		CS		MP		CS		MP		CS	
Station	d	j	d	j	d	j	d	j	d	j	d	j	d	j	d	j	d	j	d	j
1	3.24	.72	2.07	.62	2.03*	.68	3.64	.79	-	-	2.93	.65	.86	.21	-	-	2.85	.63	-	-
3	3.33	.74	2.97	.78	3.99	.85	3.46	.76	-	-	3.23	.69	.54	.15	-	-	2.66	.62	-	-
4	-	-	2.95	.79	3.73	.88	3.12	.79	-	-	2.76	.64	1.02	.23	-	-	1.90	.63	-	-
5	3.30	.73	2.79	.84	3.89	.83	3.15	.74	-	-	3.27	.69	.72	.17	-	-	2.72	.63	-	-
6	3.38	.74	2.71	.82	3.00	.63	2.29	.49	-	-	3.31	.69	2.87	.66	-	-	2.69	.66	-	-
$\bar{x}$	3.31	.73	2.70	.77	3.66	.80	3.13	.71	-	-	3.10	.67	1.20	.28	-	-	2.56	.63	-	-

MP = Multiple Plate (based on composite of all samplers retrieved, Appendix II).

CS = Circular Sample (based on a composite of three samples).

* = One sample only, not included in $\bar{x}$ calculation.

d = Diversity

j = Eveness

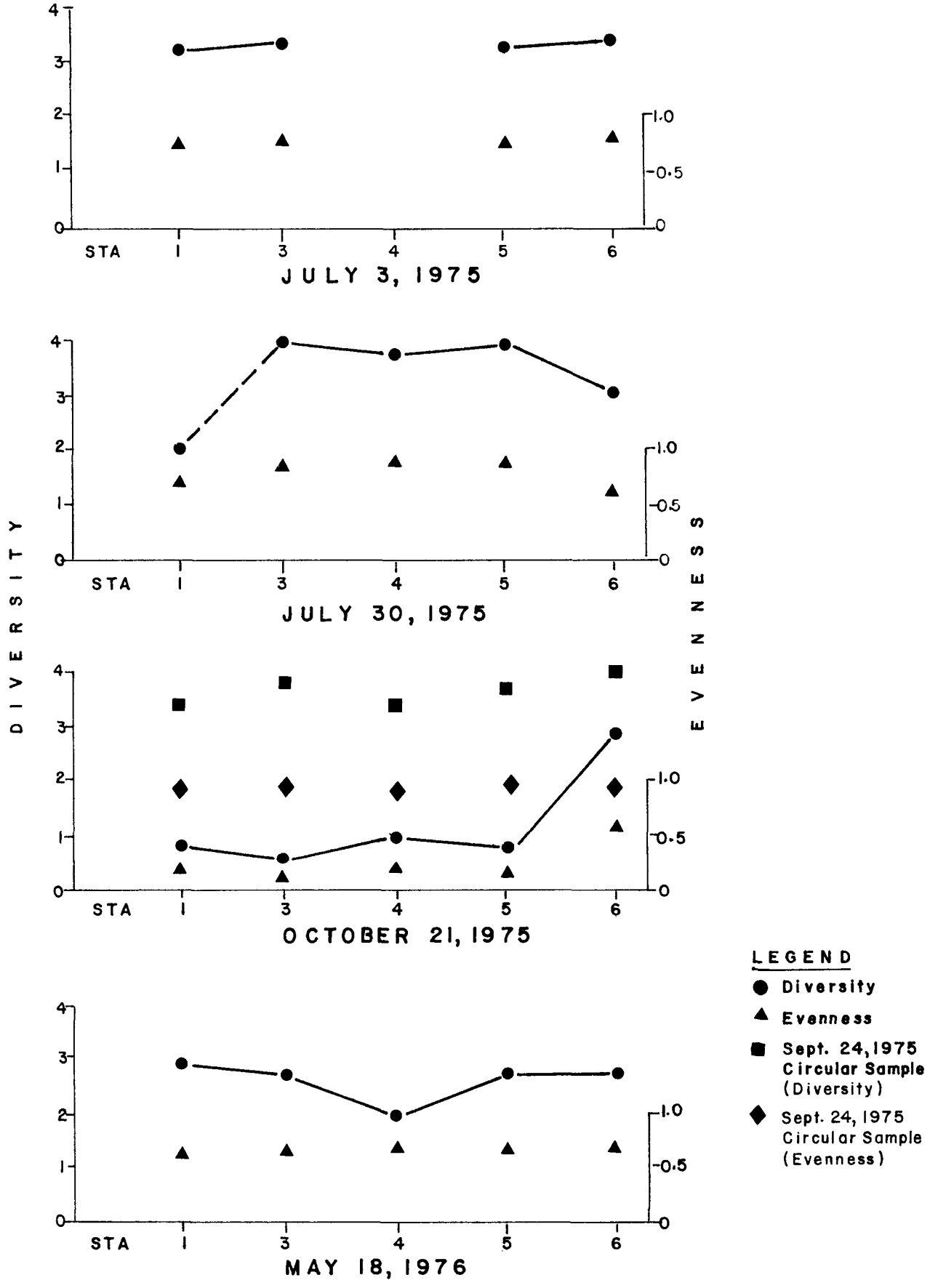

FIGURE 4 BESSETTE CREEK, 1975-76 - DIVERSITY AND EVENNESS FOR MULTIPLE PLATE SAMPLERS

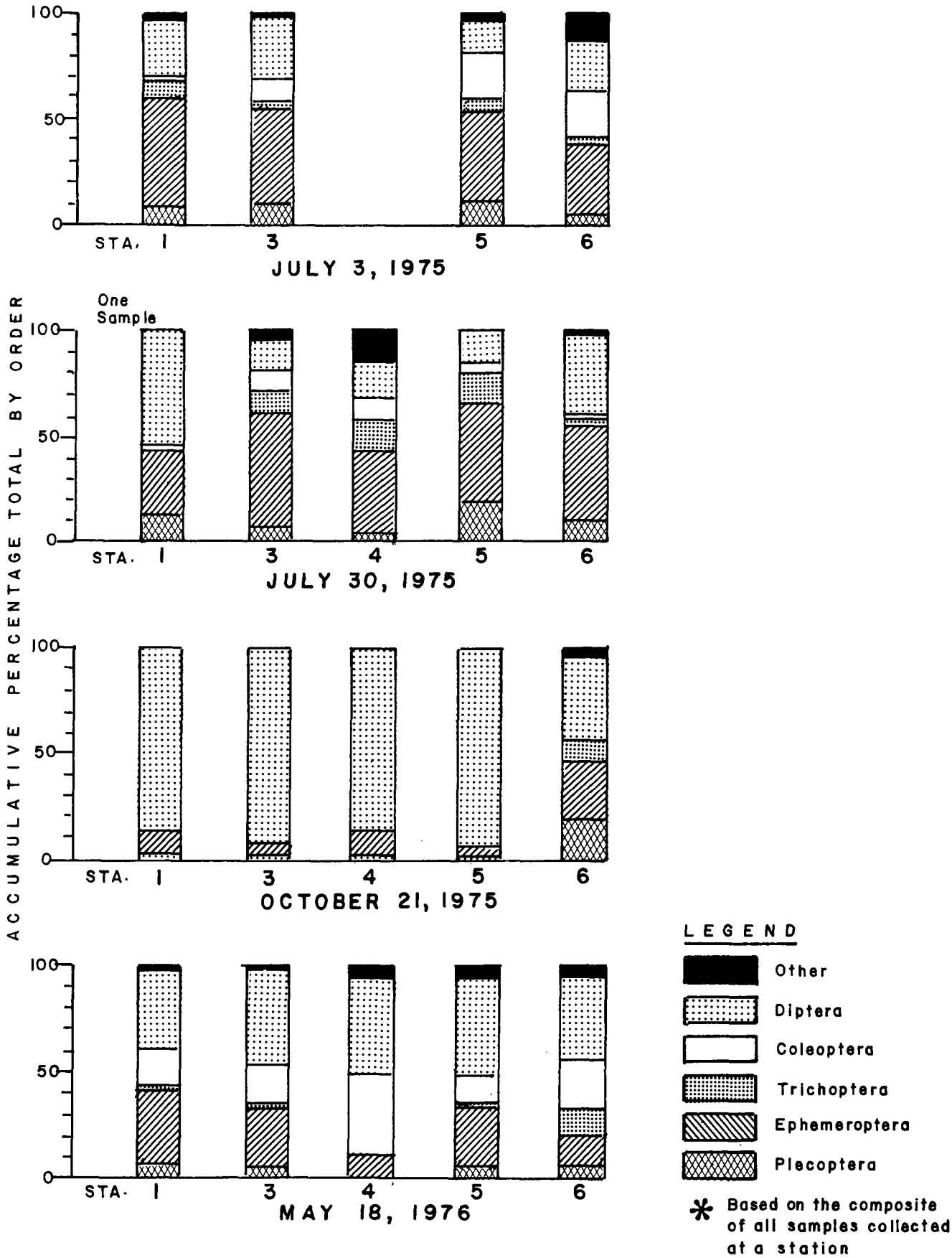

FIGURE 5 BESSETTE CREEK, 1975 - 1976 ACCUMULATIVE PERCENTAGE TOTAL* OF ORGANISMS BY ORDER FOR MULTIPLE PLATE SAMPLERS

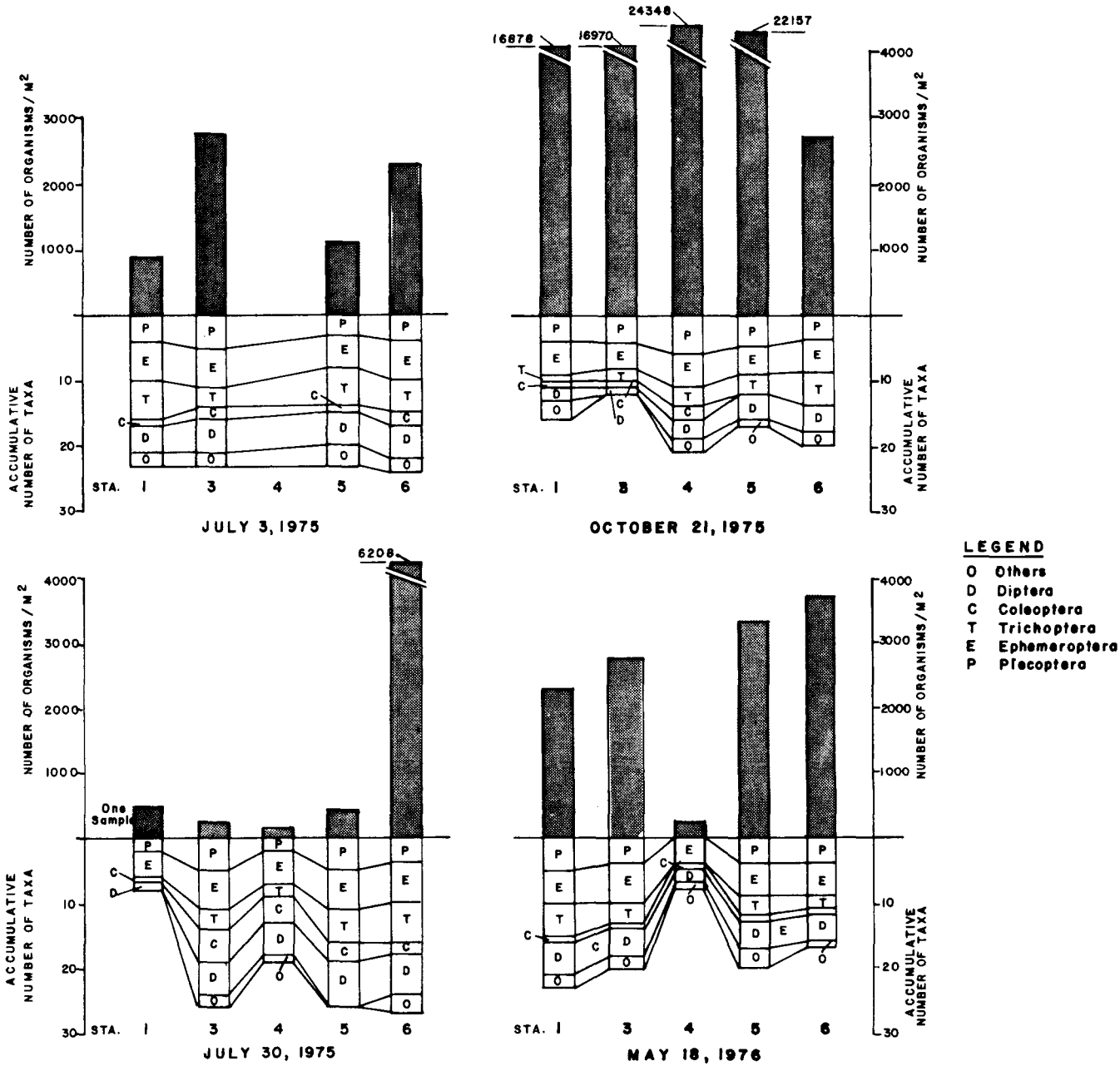

FIGURE 6 BESSETTE CREEK, 1975 - 1976 - MEAN NUMBER OF ORGANISMS PER M^2 AND TOTAL NUMBER OF TAXA FOR MULTIPLE PLATE SAMPLERS

temperate streams in autumn are characterized by eggs hatching, an increase in numbers and growth of invertebrates, and emergence of insects from resting states. In the case of Bessette Creek the October 1975, reduction in diversity is a result of an increase in the number of chironomidae. The high diversity of station 6 during October 1975 indicates the dissimilarity of this station.

With the exception of October 1975, plecoptera and ephemeroptera made up a major part of the macroinvertebrate community colonizing the multiple plate samplers (Figure 5). In October 1975, a large number of chironomidae were sampled thus reducing the accumulative percentage total of sensitive organisms (Figure 5) but not appreciably affecting the number of identifiable taxa of sensitive organisms (Figure 6).

During the period the multiple plate samplers were reset July 3, 1975 and collected on July 30, 1975, a work crew engaged in some dyking work along the full length of the lagoon's creek edge (Figure 2). The net result of this work was not evident in the diversity or eveness of organisms, percent accumulative total or number of identifiable taxa but appeared to be appreciable with regards to a reduction in density of organisms if the increase in numbers at station 6 is indicative for the creek as a whole. However, this may not be the case as indicated previously.

Unfortunately, all but one of the control station multiple plate samplers were destroyed as a result of this action but the data indicates the impact of the work may have extended downstream to station 5 (.5 km downstream). Circular samples showed a similar response with the density of macroinvertebrates at stations 1 to 4 being much lower than the large increase noted at station 6 (Figure 7). It is not certain whether the low density of organisms in the circular samples at the control station 1 on July 30, 1975, is an artifact of the construction work.

Williams et al, 1977, report that natural benthic densities may be returned to small areas of riffle substrate 15 days after all the animals have been removed but some species may take as long as 24 days to recolonize. Williams et al, 1977, suggest that the full recovery of

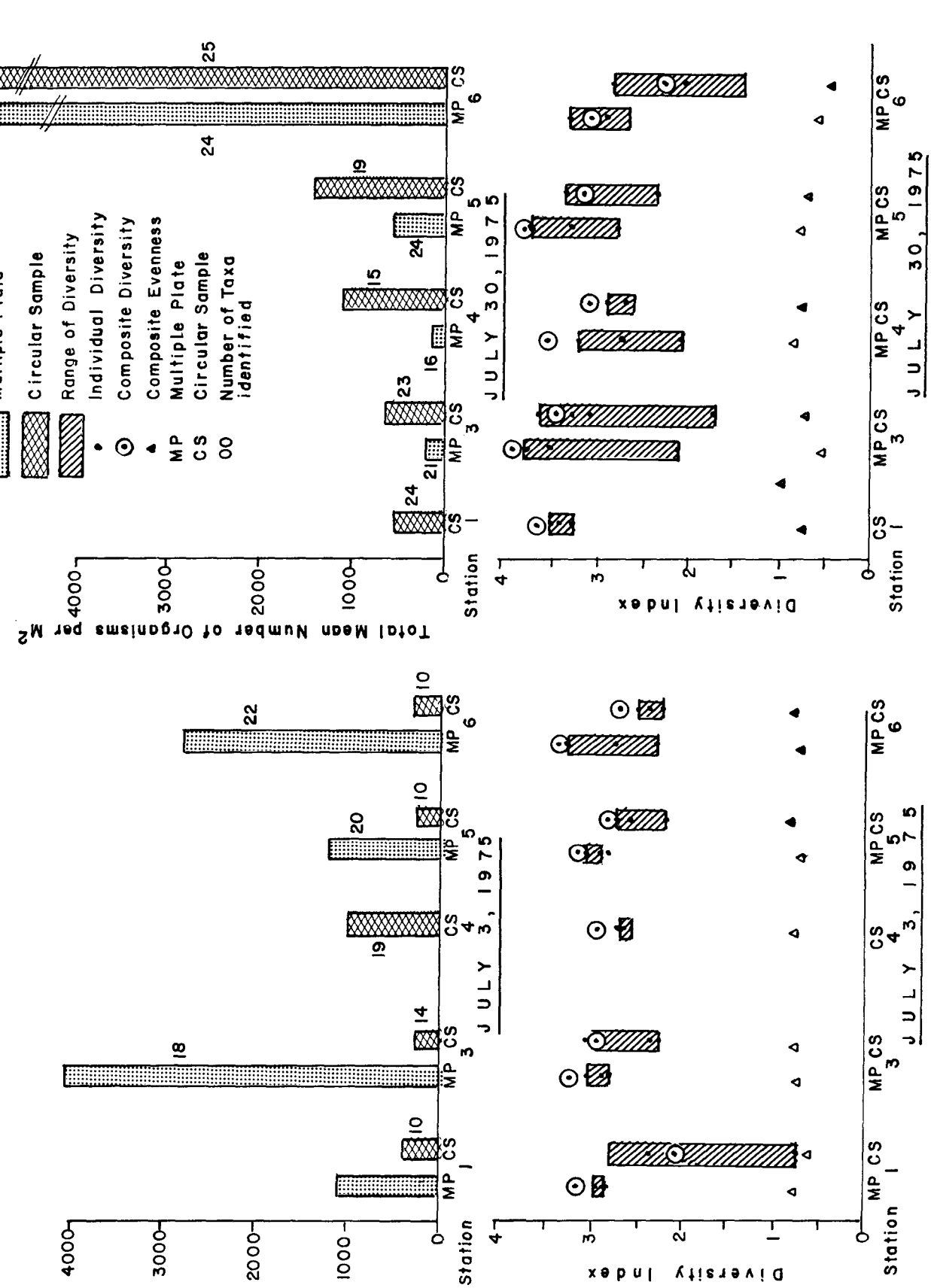

FIGURE 7 BIOLOGICAL INDICIES - MULTIPLE PLATE SAMPLER VERSUS CIRCULAR SAMPLER, BESSETTE CREEK, B.C. (Based on a composite of three samples for each sample method)

total numbers after only two weeks could be due to the over compensation by some species. A four-week period may be more appropriate for complete recolonization of all taxa (Williams and Hynes, 1976).

Circular samples were taken concurrently with retrieval of multiple plates on July 3, 1975 and July 30, 1975 and once separately in September 1975. Diversity values were generally lower for the circular samples (Table 3, Figure 7) but were sufficiently high to indicate a clean water stream (range: 2.07 - 3.64, mean: 2.98) and the values in September 1975 (2.76 - 3.31) were not lower than those reported in July (Table 3). A comparison of the various orders collected and number of families in each order are shown in Figure 8. The July 3 and 30, 1975 samples indicated the multiple plates to be more selective for ephemeroptera and the July 3, 1975 multiple plate samples had a more diverse fauna of ephemeroptera. Diptera made up a greater portion of the sample in the circular samples than for the multiple plate samples (Figure 8). Eisele and Hartung, 1976, found that multiple plate samplers showed similar trends as a modified Hess sampler with respect to macroinvertebrate community structure.

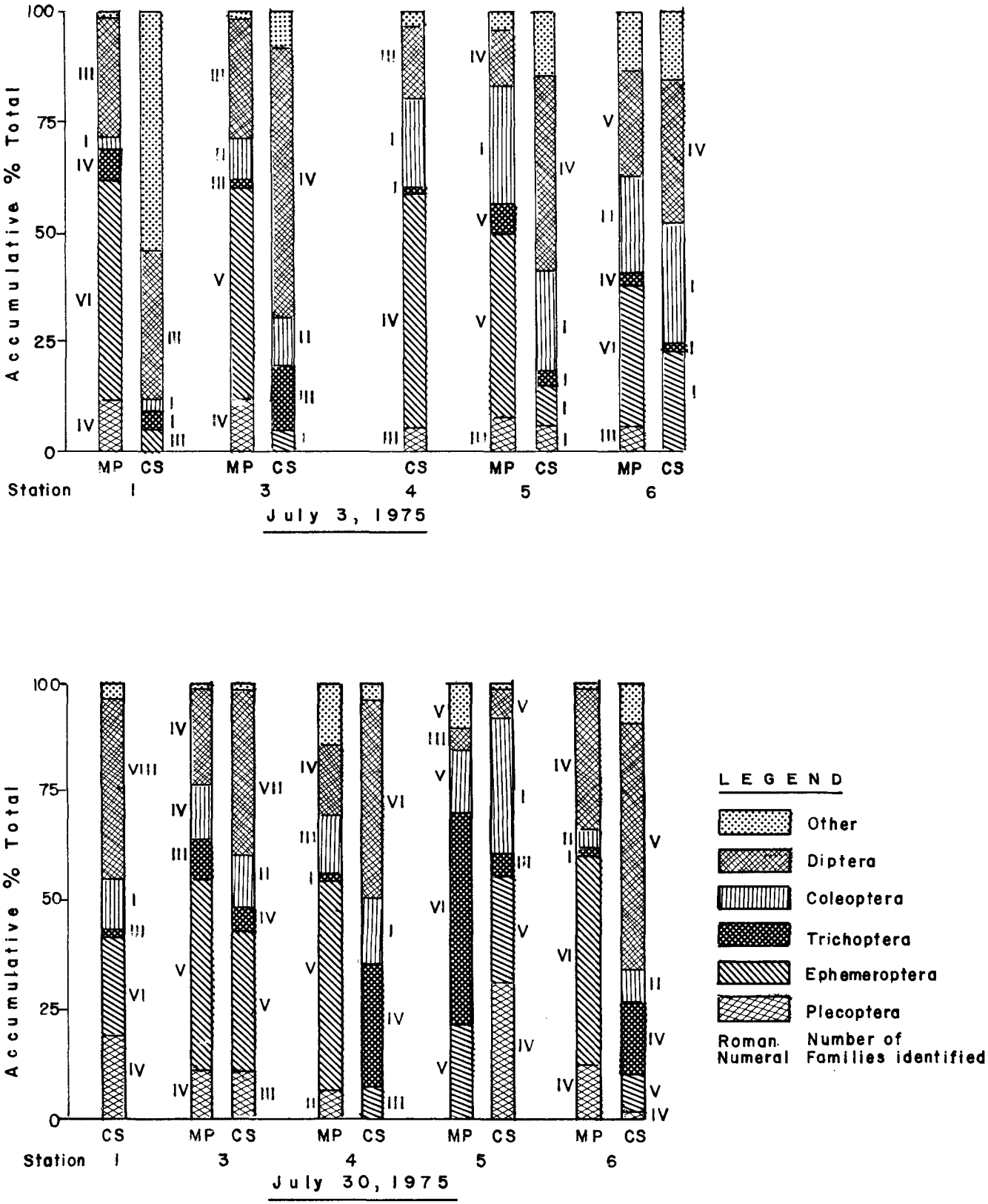

FIGURE 8 ACCUMULATIVE % TOTAL OF ORGANISMS - MULTIPLE PLATE SAMPLER VERSUS CIRCULAR SAMPLER, BESSETTE CREEK, B.C. (Based on a composite of three samples for each sample method)

REFERENCES

Anonymous, Environment Canada, Pollution Sampling Handbook, (1976)

Buckley, J.A., "Acute Toxicity of Residual Chlorine in Wastewater to Coho Salmon (Oncorhynchus kisutch) and Some Resultant Hematologic Changes", J. Fish. Res. Board Can., 33, pp. 2854-2856, (1976).

Buckley, J.A., C.M. Whitmore and R.I. Matsuda, "Changes in Blood Chemistry and Blood Cell Morphology in Coho Salmon (Oncorhynchus kisutch) Following Exposure to Sublethal Levels of Total Residual Chlorine in Municipal Wastewater", J. Fish. Res. Board Can., 33, pp. 776-782, (1976).

Cairns, J., and K.L. Dickson, "A Simple Method for the Biological Assessment of the Effects of Water Discharges on Aquatic Bottom-Dwelling Organisms", J. Water Pollut. Control Fed., 43, pp. 775-782, (1971).

Dickson, K.L., J. Cairns Jr., B.C. Gregg, D.I. Messanger, J.L. Plafkin and Hvander Schalie, "Effects of Intermittent Chlorination on Aquatic Organisms and Communities", J. Water Pollut. Control Fed., 49, pp. 35-44 (1977).

Dills, G., and D.T. Rogers, Macroinvertebrate Community Structure as an Indicator of Acid Mine Pollution, Environ. Pollut. (6), pp. 239-262, (1974).

Eisele, P.J., and R. Hartung, "The Effects of Methoxyclor on Riffle Invertebrate Populations and Communities", Trans. Am. Fish. Soc., 105, pp. 628-633, (1976).

Filip, D.S., and E.J. Middlebrooks, "Eutrophication Potential of Dairy Cattle Waste Runoff", Wastewater Research, 10, pp. 39-93 (1976).

Goodnight, C.J., "The Use of Aquatic Macroinvertebrates as Indicators of Stream Pollution", Trans. Am. Microsc. Soc., 92, pp. 1-13, (1973).

Hess, A.D., New Limnological Sampling Equipment, The American Society of Limnology and Oceanography, Special Publication 6, pp. 1-5, (1941).

Hester, F.E., and J.B. Dendy, "A Multiple Plate Sampler for Aquatic Macroinvertebrates", Trans. Am. Fish. Soc., 91, pp. 420, (1962).

Hughes, B.D., "A Comparison of Four Samplers for Benthic Macroinvertebrates Inhabiting Coarse River Deposits", Water Research, 9, pp. 61-69, (1975).

Hughes, B.D., "The Influence of Factors Other Than Pollution on the Value of Shannon's Diversity Index for Benthic Macroinvertebrates in Streams", Water Research, 12, pp. 359, (1978).

Hynes, H.B.N., The Ecology of Running Waters, University of Toronto Press, Toronto, Ontario, Canada, (1970).

McKee, J.E., and H.W. Wolfe, Water Quality Criteria, The Resources Agency of California State Water Resources Control Board, Publication No. 3-A, (1963).

Martens, D.W., and J.A. Servizi, Acute Toxicity of Municipal Sewage Fingerling Sockeye Salmon, International Pacific Salmon Fisheries Commission Progress Report No. 29, (1974).

Mattice, J.S., and H.E. Zittel, "Site-specific Evaluation of Power Plant Chlorination", J. Water Pol. Control Fed., 48, pp. 2284-2308, (1976).

Oldham, W.K., Water Pollution Potential of Spray Irrigation by Using Secondary Effluent. Presented at Technology Transfer Seminar - Notes, Department of the Environment, Environmental Protection Service, (1975).

Peckarsky, B.L., Biological Interactions as Determinants of Distributions of Benthic Invertebrates Within the Substrate of Stony Streams, The American Society of Limnology and Oceanography, Vol. 24, pp. 59-68, (1979).

Pennack, R.W., Freshwater Invertebrates of the United States, The Ronald Press Co., New York, (1953).

Pielou, E.C., "The Measurements of Diversity in Different Types of Biological Collections," J. Theor. Biol., 13, pp. 131-144, (1966).

Resh, V.H., and J.D. Unzicker, "Water Quality Monitoring and Aquatic Organisms: The Importance of Species Identification", J. Water Pollut. Control Fed., 47, pp. 9-19, (1975).

Rosenburg, D.M., and A.P. Wiens, "Effects of Sediment Addition on Macrobenthic Invertebrates in a Northern Canadian River", Water Research, 12, pp. 753-763, (1978).

Servizi, J.A., and R.A. Burkhalter, Selected Measurements of Water Quality and Bottom-Dwelling Organisms of the Fraser River System 1963 to 1968. International Pacific Salmon Fisheries Commission, (1970).

Servizi, J.F., and D.W. Martens, Preliminary Survey of Toxicity of Chlorinated Sewage to Sockeye and Pink Salmon, International Pacific Salmon Fisheries Commission Progress Report No. 30, (1974).

Shannon, C.E., and W. Weaver, The Mathematical Theory of Communication, Urbana, University of Illinois Press, (1963).

Usinger, R.L., et al, Aquatic Insects of California, University of California Press, (1968).

Ward, H.B., and G.C. Whipple, Freshwater Biology, 2nd Edition, John Wiley and Sons, Inc., New York (1959).

Waters, T.F., The Drift of Stream Insects, Paper No. 7630 Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota 55101, (1972).

Waters T.F., and R.J. Knapp, "An Improved Stream Bottom Fauna Sampler", Trans. Am. Fish. Soc., 90, pp. 225-226, (1961).

Water Quality Criteria, Ecological Research Series, EPA R3-73-033, (1972).

Water Survey of Canada, Surface Water Data (1973-1976), Inland Waters Directorate, Ottawa, Canada (1974-1976).

Whitton, B.A., et al, River Ecology, University of California Press (1975).

Wilhm, J.L., and T.C. Dorris, "Biological Parameters for Water Quality Criteria", Bioscience, 48, pp. 477-481, (1968).

Wilhm, J.L., "Range of Diversity Index in Benthic Macroinvertebrate Populations", J. Water Pollut. Control Fed., 45, pp. 2269-2275, (1970).

Williams, D.D., and H.B. Hynes, "The Recolonization Mechanisms of Stream Benthos", Oikos, 27, pp. 265-272, (1976).

Williams, D.D., J.H. Mundie, and D.E. Mounce, "Some Aspects of Benthic Production in a Salmonid Rearing Channel", J. Fish. Res. Board Can., 34, pp. 2133-2141, (1977).

ACKNOWLEDGEMENTS

The author would like to thank all individuals who participated in the field work, particularly B. Kovish.

Thanks are also extended to B. Kelso and O. Langer for their constructive review of this manuscript.

Macroinvertebrate identification and enumerations were made by Mr. John Keyes.

APPENDICES

APPENDIX I

SAMPLE STATION DESCRIPTION

APPENDIX I SAMPLE STATION DESCRIPTION

Sample Site	Location	Substrate	General
1	Immediately upstream of Lagoon	primarily fine to coarse rubble and some coarse gravel. Sand and fine gravel present.	Riffle area but deeper than 3, 5, 6. Fast flowing.
3	Approx. 10 m upstream of proposed outfall	primarily coarse gravel to fine rubble and some coarse rubble. Sand and fine gravel commonly intermixed.	Riffle area and fast flowing.
4	Approx. 10 m downstream of proposed outfall	primarily sand to coarse gravel with some fine rubble.	Area of sand/gravel build up. Fast flowing but not riffle area as such.
5	Approx. 0.5 km downstream of Lagoon	primarily coarse gravel to fine rubble and some coarse rubble. Sand and fine gravel commonly intermixed.	Immediately upstream of private bridge. Riffle area and generally fast flowing but reduced flows east side and more sandy.
6	Approx. 6.5 km downstream of Lagoon	primarily fine-coarse rubble and some boulders. Some fine-coarse gravel with areas of sand along shore.	Immediately downstream of highway bridge. Riffle area and fast flowing. Some build up of sandy areas.

APPENDIX II

MACROINVERTEBRATE SAMPLING ANALYSES

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **1**
Date: **3/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	12						24
Chloroperlidae	9	4					26
Nemouridae			1		3		8
Perlidae							
Pteronarcidae	5		4				18
Perlodidae							
Ephemeroptera	2						4
Baetidae	52	2	26	12	11		206
Behningiidae							
Ephemerellidae	11	2	7	8	5		66
Heptageniidae	2				9		22
Leptophlebiidae	41	5	13	12	16		174
Siphlonuridae			1				2
Trichoptera		3	1				8
Brachycentridae					8		16
Glossomatidae	13						26
Hydropsychidae		3					6
Leptoceridae					2		4
Limnephilidae			2		5		14
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae		5	6				22
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae					1		2
Chironomidae	65	8	11	12	14		220
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae			1				2
Tabanidae							
Tipulidae	8						16
Anisopodidae							
Nematocera							
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	3		5				16
Oligochaeta	1						2
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							904
Total Number of Taxa	13	8	12	4	10		23

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 3
Date: **3/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	26						52
Chloroperlidae	4	2		2			20
Nemouridae					4		8
Perlidae		2					4
Pteronarcidae	20	4	72	4			200
Perlodidae							
Ephemeroptera	72	28					200
Baetidae	54	104	68		6		464
Behnirgiidae							
Ephemerellidae	36	82	40		4		324
Heptageniidae	6	18	8				64
Leptophlebiidae	6	42	34				164
Siphlonuridae				6			12
Trichoptera							
Brachycentridae							
Glossomatidae			8	2	2		24
Hydropsychidae			6		14		40
Leptoceridae							
Limnephilidae	2	2					8
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae			2				4
Elmidae	98	28					252
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae					6		12
Chironomidae	72	130	96	32	22		704
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae		2		2	2		12
Anisopodidae							
Nematocera							
Brachycera				2			4
Cyclorrhapha		16	18				68
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Furmicidae							
Lepidoptera							
Acarina	26		10				72
Oligochaeta					2		4
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							2716
Total Number of Taxa	12	13	11	7	9		23

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 5
Date: 3/07/75

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	3	1	2	4	4		28
Chloroperlidae			2	3	4		18
Nemouridae							
Perlidae							
Pteronarcidae	6	10	1	20	7		88
Perlodidae							
Ephemeroptera	7	8	2	1	8		52
Baetidae	25	36	29	31	6		254
Behnirgiidae		1					2
Ephemerellidae	21	17	3	7	17		130
Heptageniidae	6		2				16
Leptophlebiidae							
Siphlonuridae							
Trichoptera							
Brachycentridae				1			2
Glossomatidae			2				4
Hydropsychidae	1	3	3				14
Leptoceridae	7	1	8	7	1		48
Limnephilidae							
Phryganeidae			1				2
Psychomyiidae							
Rhyacophilidae		1					2
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae	61	14	24	11	10		240
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae	3	4		8	4		38
Chironomidae	18	12	8	4	10		104
Tanyderidae							
Psychodidae				1			2
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae							
Anisopodidae			1				2
Nematocera							
Brachycera							
Cyclorrhapha			1				2
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae				1			2
Lepidoptera							
Acarina	4	1	8	3	4		40
Oligochaeta	1		1	1			6
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							1096
Total Number of Taxa	13	13	17	15	11	23	23

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **6**
Date: **3/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	-		20				50
Chloroperlidae	-		19		3		55
Nemouridae	-						
Perlidae	-				1		2
Pteronarcidae	-		3		1		10
Perlodidae	-						
Ephemeroptera	-	2	22	40	4		170
Baetidae	-	10	23	18	11		155
Behnirgiidae	-						
Ephemerellidae	-	36	35	24	9		260
Heptageniidae	-	4	2	8			35
Leptophlebiidae	-		28	4	5		92
Siphlonuridae	-		12				30
Trichoptera	-						
Brachycentridae	-	4	7				27
Glossomatidae	-			6			15
Hydropsychidae	-				2		5
Leptoceridae	-	2	1				7
Limnephilidae	-			2			5
Phryganeidae	-						
Psychomyiidae	-						
Rhyacophilidae	-						
Coleoptera	-						
Haliplidae	-						
Chrysomelidae	-						
Curculionidae	-						
Dytiscidae	-		1				2
Elmidae	-	34	48	98	28		520
Helodidae	-						
Hydrophilidae	-						
Dryopidae	-						
Amphizoidae	-						
Diptera	-						
Ceratopogonidae	-			6			15
Chironomidae	-	14	71	96	1		455
Tanyderidae	-						
Psychodidae	-						
Rhagionidae	-						
Simuliidae	-						
Tabanidae	-						
Tipulidae	-	4	2	2	1		22
Anisopodidae	-						
Nematocera	-			2	1		7
Brachycera	-						
Cyclorrhapha	-		1				2
OTHER							
Hemiptera	-						
Notonectidae	-						
Hymenoptera	-						
Formicidae	-						
Lepidoptera	-						
Acarina	-		2	28	2		80
Oligochaeta	-	96	1	2			247
Tubificidae	-						
Nematoda	-						
Hirudinea	-						
Gastropoda	-						
Total Number of Organisms							2268
Total Number of Taxa		10	18	14	13		24

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **1**
Date: **30/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2					Total (0.5 m^2)	Number of Organisms per m^2
	Sample Number						
	1	2	3	4	5		
Plecoptera		-	-	-	-		
Chloroperlidae	1	-	-	-	-		10
Nemouridae		-	-	-	-		
Perlidae		-	-	-	-		
Pteronarcidae	6	-	-	-	-		60
Perlodidae		-	-	-	-		
Ephemeroptera		-	-	-	-		
Baetidae	9	-	-	-	-		90
Behningiidae		-	-	-	-		
Ephemerellidae	2	-	-	-	-		20
Heptageniidae	1	-	-	-	-		10
Leptophlebiidae	5	-	-	-	-		50
Siphlonuridae		-	-	-	-		
Trichoptera		-	-	-	-		
Brachycentridae		-	-	-	-		
Glossomatidae		-	-	-	-		
Hydropsychidae		-	-	-	-		
Leptoceridae		-	-	-	-		
Limnephilidae		-	-	-	-		
Phryganeidae		-	-	-	-		
Psychomyiidae		-	-	-	-		
Rhyacophilidae		-	-	-	-		
Coleoptera		-	-	-	-		
Haliplidae		-	-	-	-		
Chrysomelidae		-	-	-	-		
Curculionidae		-	-	-	-		
Dytiscidae	1	-	-	-	-		10
Elmidae		-	-	-	-		
Helodidae		-	-	-	-		
Hydrophilidae		-	-	-	-		
Dryopidae		-	-	-	-		
Amphizoidae		-	-	-	-		
Diptera		-	-	-	-		
Ceratopogonidae		-	-	-	-		
Chironomidae	31	-	-	-	-		310
Tanyderidae		-	-	-	-		
Psychodidae		-	-	-	-		
Rhagionidae		-	-	-	-		
Simuliidae		-	-	-	-		
Tabanidae		-	-	-	-		
Tipulidae		-	-	-	-		
Anisopodidae		-	-	-	-		
Nematocera		-	-	-	-		
Brachycera		-	-	-	-		
Cyclorrhapha		-	-	-	-		
OTHER							
Hemiptera		-	-	-	-		
Notonectidae		-	-	-	-		
Hymenoptera		-	-	-	-		
Formicidae		-	-	-	-		
Lepidoptera		-	-	-	-		
Acarina		-	-	-	-		
Oligochaeta		-	-	-	-		
Tubificidae		-	-	-	-		
Nematoda		-	-	-	-		
Hirudinea		-	-	-	-		
Gastropoda		-	-	-	-		
Total Number of Organisms							560
Total Number of Taxa	8						8

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **3**
Date: **30/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera		1		1			4
Chloroperlidae	1	1		1			6
Nemouridae							
Perlidae					1		2
Pteronarcidae			1				2
Perlodidae		2					4
Ephemerontera		1	2		2		10
Baetidae			1	5	2		16
Behnirgiidae							
Ephemerellidae		2	3	4	3		24
Heptageniidae					5		10
Leptophlebiidae	6	4	1	19	2		64
Siphlonuridae	2	1	2	1			12
Trichoptera		1	1		4		12
Brachycentridae							
Glossomatidae							
Hydropsychidae			1				2
Leptoceridae							
Limnephilidae		1	1	3	2		14
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae				1			2
Chrysomelidae							
Curculionidae							
Dytiscidae		1	1	3			10
Elmidae	1		2	1			8
Helodidae							
Hydrophilidae							
Dryopidae		1					2
Amphizoidae		1					2
Diptera			1				2
Ceratopogonidae							
Chironomidae	1		2		1		8
Tanyderidae	1	5	2				16
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae					2		4
Anisopodidae							
Nematocera							
Brachycera							
Cyclorrhapha			1	1			4
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina		1		1			4
Oligochaeta				2	1		6
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							250
Total Number of Taxa	6	14	15	13	11		26

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **4**
Date: 30/07/75

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera							
Chloroperlidae			2				4
Nemouridae							
Perlidae							
Pteronarcidae			1				2
Perlodidae							
Ephemeroptera		3	4				14
Baetidae							
Behnirgiidae							
Ephemerellidae			1				2
Heptageniidae			2				4
Leptophlebiidae		3	7	2	1		26
Siphlonuridae		1	2	2	2		14
Trichoptera			1	1			4
Brachycentridae							
Glossomatidae							
Hydropsychidae							
Leptoceridae							
Limnephilidae				1	8		18
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae				1			2
Chrysomelidae							
Curculionidae							
Dytiscidae		1	1				4
Elmidae	2	1					6
Helodidae							
Hydrophilidae							
Dryopidae			1				2
Amphizoidae							
Diptera					2		4
Ceratopogonidae							
Chironomidae	1	1	2	1			10
Tanyderidae		1	1	1			6
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae	1				1		4
Anisopodidae							
Nematocera	1						2
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina							
Oligochaeta	3	4		3	1		22
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							150
Total Number of Taxa	5	8	12	8	6		19

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 5
Date: 30/07/75

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera							
Chloroperlidae	3	2					10
Nemouridae		1					2
Perlidae	2	4	2	2			20
Pteronarcidae	11	9		1	2		46
Perlodidae		2					4
Ephemeroptera	3	4					14
Baetidae	4	5	7	4	1		42
Behnirgiidae							
Ephemerellidae	6	16	20	2			88
Heptageniidae	1	1	1	2	4		18
Leptophlebiidae	2	3	2				14
Siphlonuridae	3	4	1				16
Trichoptera	1	2					6
Brachycentridae		1					2
Glossomatidae							
Hydropsychidae		3					6
Leptoceridae							
Limnephilidae	3	2	9	4			26
Phryganeidae							
Psychomyiidae							
Rhyacophilidae		4					8
Coleoptera							
Haliplidae		1					2
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae	1		4	4			18
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae	1						2
Diptera					2		4
Ceratopogonidae				2			4
Chironomidae		3	8	4	1		32
Tanyderidae		1					2
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae			2	1			6
Anisopodidae							
Nematocera			2				4
Brachycera							
Cyclorrhapha			1				2
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Furmicidae							
Lepidoptera							
Acarina							
Oligochaeta							
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							398
Total Number of Taxa	13	19	12	10	5		26

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **6**
Date: **30/07/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera		8	16	6	12		82
Chloroperlidae	6	8		6	6		52
Nemouridae							
Perlidae							
Pteronarcidae	24	36	46	30	63		538
Perlodidae		4	8	4			32
Ephemeroptera		16	4	8	18		92
Baetidae	39	48	164	134	174		1118
Behningiidae							
Ephemerellidae	123	82	212	42	57		1032
Heptageniidae	18	14	24	6	6		136
Leptophlebiidae	78	20	52	14	18		364
Siphlonuridae	12	8	8	2	3		66
Trichoptera		2					4
Brachycentridae				4	3		14
Glossomatidae		4					8
Hydropsychidae		4		4	12		40
Leptoceridae							
Limnephilidae							
Phryganeidae							
Psychomyiidae	3	8	12	2			50
Rhyacophilidae	3						6
Coleoptera							
Haliplidae							
Chrysomelidae	3	16	8		3		60
Curculionidae							
Dytiscidae							
Elmidae	3	8	32	2	6		102
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae							
Chironomidae	204	156	220	160	336		2152
Tanyderidae		4					8
Psychodidae	3		4				14
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae				4			8
Anisopodidae							
Nematocera	9	12	16	6	12		110
Brachycera							
Cyclorrhapha				2			4
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	3						6
Oligochaeta	6	24	4	10	12		112
Tubificidae							
Nematoda	3						6
Hirudinea							
Gastropoda							
Total Number of Organisms							6208
Total Number of Taxa	17	20	16	19	16		27

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **1**
Date: **21/10/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera		4			2		12
Chloroperlidae		1	1	8	2		24
Nemouridae							
Perlidae							
Pteronarcidae	7	6	5	4	7		58
Perlodidae	12	6	15	2			70
Ephemeroptera							
Baetidae	92	55	39	229	337		1504
Behningiidae							
Ephemerellidae	1	1	3	6	9		40
Heptageniidae	10	18	4	36	35		206
Leptophlebiidae	13	9	22	129	21		388
Siphlonuridae		4					8
Trichoptera		8		14			44
Brachycentridae							
Glossomatidae							
Hydropsychidae							
Leptoceridae							
Limnephilidae							
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae		1	1	14			32
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae							
Chironomidae	1759	1217	1031	1655	1565		14454
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae							
Anisopodidae							
Nematocera		2	1	1	2		12
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Furmicidae							
Lepidoptera							
Acarina	4	4					16
Oligochaeta							
Tubificidae							
Nematoda					4		8
Hirudinea							
Gastropoda			1				2
Total Number of Organisms							16878
Total Number of Taxa	8	14	11	11	10		16

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plates**
Station No: 3
Date: 21/10/75

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera			4	8	-		30
Chloroperlidae			12	6	-		45
Nemouridae					-		
Perlidae	1	2	2	4	-		22
Pteronarcidae	3	8	5	16	-		80
Perlodidae					-		
Ephemeroptera					-		
Baetidae	19	69	70	120	-		696
Behningiidae					-		
Ephemerellidae	7	3	15	4	-		72
Heptageniidae	5	10	19	23	-		142
Leptophlebiidae		5	13	4	-		56
Siphlonuridae					-		
Trichoptera			4	8	-		30
Brachycentridae					-		
Glossomatidae					-		
Hydropsychidae	1	8	7	1	-		42
Leptoceridae					-		
Limnephilidae					-		
Phryganeidae					-		
Psychomyiidae					-		
Rhyacophilidae					-		
Coleoptera					-		
Haliplidae				4	-		10
Chrysomelidae					-		
Curculionidae					-		
Dytiscidae					-		
Elmidae					-		
Helodidae					-		
Hydrophilidae					-		
Dryopidae					-		
Amphizoidae					-		
Diptera					-		
Ceratopogonidae					-		
Chironomidae	1910	2116	656	1616	-		15745
Tanyderidae					-		
Psychodidae					-		
Rhagionidae					-		
Simuliidae					-		
Tabanidae					-		
Tipulidae					-		
Anisopodidae					-		
Nematocera					-		
Brachycera					-		
Cyclorrhapha					-		
OTHER							
Hemiptera					-		
Notonectidae					-		
Hymenoptera					-		
Formicidae					-		
Lepidoptera					-		
Acarina					-		
Oligochaeta					-		
Tubificidae					-		
Nematoda					-		
Hirudinea					-		
Gastropoda					-		
Total Number of Organisms							16970
Total Number of Taxa	7	8	11	12			12

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **4**
Date: **21/10/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	8	5		80	32		250
Chloroperlidae	2	5					14
Nemouridae			1		1		4
Perlidae	7	8					30
Pteronarcidae	3			2	1		12
Perlodidae				3			6
Ephemeroptera							
Baetidae	208	91	80	455	351		2370
Behningiidae							
Ephemerellidae	4	2	7	1			28
Heptageniidae	19	19	25	14	6		166
Leptophlebiidae	9	61	7	9	29		230
Siphlonuridae	1	2					6
Trichoptera		4					8
Brachycentridae				1	1		4
Glossomatidae							
Hydropsychidae	1		1	1	1		8
Leptoceridae							
Limnephilidae							
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae		1					2
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae			1				2
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera				5	4		18
Ceratopogonidae							
Chironomidae	2329	319	2146	2518	3231		21086
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae							
Tabanidae							
Tipulidae							
Anisopodidae							
Nematocera	10	23	14				94
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	4						8
Oligochaeta							
Tubificidae							
Nematoda				1			2
Hirudinea							
Gastropoda							
Total Number of Organisms							24348
Total Number of Taxa	13	12	9	12	10		21

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 5
Date: 21/10/75

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number 1	2	3	4	5	Total (0.5 m^2)	Number of Organisms per m^2
Plecoptera	12	8	16	8	18		124
Chloroperlidae							
Nemouridae	1						2
Perlidae					1		2
Pteronarcidae	8	9	6	28	6		114
Perlodidae	2	7		5	11		50
Ephemeroptera							
Baetidae	52	58	231	57	57		910
Behningiidae							
Ephemerellidae	2	8	5	4	3		44
Heptageniidae	8	19	21	5	8		122
Leptophlebiidae	1	8					18
Siphlonuridae							
Trichoptera							
Brachycentridae	8		3		6		34
Glossomatidae		3	2	4			18
Hydropsychidae		8	4	1	2		30
Leptoceridae							
Limnephilidae							
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae							
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera	1	4	2		1		14
Ceratopogonidae							
Chironomidae	1411	2165	2493	2328	1931		20656
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae			8	1			18
Tabanidae							
Tipulidae	1						2
Anisopodidae							
Nematocera							
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Furmicidae							
Lepidoptera							
Acarina				4	18		44
Oligochaeta							
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							22157
Total Number of Taxa	12	11	11	11	12	17	17

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **6**
Date: **21/10/75**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera				20			40
Chloroperlidae							
Nemouridae	4			3			14
Perlidae							
Pteronarcidae	24	32	31	65	64		432
Perlodidae	2		5		7		28
Ephemeroptera							
Baetidae	59	49	13	37	13		342
Behningiidae							
Ephemerellidae	27	30	35	20	25		282
Heptageniidae	13	6	8	21	11		118
Leptophlebiidae			2				4
Siphlonuridae	1	1	5				14
Trichoptera	11	18	36	11	19		190
Brachycentridae	1						
Glossomatidae			1	4	4		18
Hydropsychidae	7	8	4	9	5		66
Leptoceridae							
Limnephilidae							
Phryganeidae							
Psychomyiidae							
Rhyacophilidae		1					2
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae							
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera		3					6
Ceratopogonidae							
Chironomidae	223	103	26	91	76		1038
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae	1						2
Tabanidae							
Tipulidae		2					4
Anisopodidae							
Nematocera							
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	16	12	5	2			70
Oligochaeta	8	12		4	8		64
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							2734
Total Number of Taxa	14	13	12	12	10	19	19

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **1**
Date: **18/05/76**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	9	15	16	11	16		134
Chloroperlidae			1	2			6
Nemouridae		1			1		4
Perlidae							
Pteronarcidae		3					6
Perlodidae	1				1		4
Ephemeroptera	36	2	9	10	3		120
Baetidae	16	15	28	8	28		190
Behningiidae							
Ephemerellidae	11	12	16	8	13		120
Heptageniidae	23	25	44	37	32		322
Leptophlebiidae		2		1	1		8
Siphlonuridae							
Trichoptera	1	1	1				6
Brachycentridae							
Glossomatidae			1	2			6
Hydropsychidae	2	1	4	3	4		28
Leptoceridae					1		2
Limnephilidae							
Phryganeidae							
Psychomyiidae			1				2
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae	33	32	36	46	55		404
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae		1			1		4
Chironomidae	96	47	104	87	88		844
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae			1				2
Tabanidae							
Tipulidae		3					6
Anisopodidae							
Nematocera	1	6	3	2			24
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	8	4	2	4	5		46
Oligochaeta		3					6
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							2294
Total Number of Taxa	12	17	15	13	14		23

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **3**
Date: **18/05/76**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	21	12	12	2	9		112
Chloroperlidae		1					2
Nemouridae							
Perlidae							
Pteronarcidae		2		6			16
Perlodidae	1				1		4
Ephemeroptera	5	11	2	10	1		58
Baetidae	38	47	12	14	13		248
Behningiidae							
Ephemerellidae	12	26	9	26	17		180
Heptageniidae	45	33	20	19	14		262
Leptophlebiidae	2	2		3	2		18
Siphlonuridae	1						2
Trichoptera	1	2		1			8
Brachycentridae							
Glossomatidae							
Hydropsychidae	1	9		6	3		38
Leptoceridae							
Limnephilidae							
Phryganeidae		1		1			4
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae	75	67	28	42	37		498
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae							
Chironomidae	145	169	79	124	82		1198
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae	1	3	1				10
Tabanidae							
Tipulidae	1	1	1		2		10
Anisopodidae							
Nematocera	3	2	3	1	2		22
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae		1					2
Lepidoptera							
Acarina	16	4	5	6	3		68
Oligochaeta							
Tubificidae							
Nematoda							
Hirudinea							
Gastropoda							
Total Number of Organisms							2760
Total Number of Taxa	16	18	11	14	13		20

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: **4**
Date: **18/05/76**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	-	-					
Chloroperlidae	-	-					
Nemouridae	-	-					
Perlidae	-	-					
Pteronarcidae	-	-					
Perlodidae	-	-					
Ephemeroptera	-	-			1		3
Baetidae	-	-			1		3
Behningiidae	-	-					
Ephemerellidae	-	-					
Heptageniidae	-	-			5		17
Leptophlebiidae	-	-			1		3
Siphlonuridae	-	-					
Trichoptera	-	-					
Brachycentridae	-	-					
Glossomatidae	-	-					
Hydropsychidae	-	-					
Leptoceridae	-	-					
Limnephilidae	-	-					
Phryganeidae	-	-					
Psychomyiidae	-	-					
Rhyacophilidae	-	-					
Coleoptera	-	-					
Haliplidae	-	-					
Chrysomelidae	-	-					
Curculionidae	-	-					
Dytiscidae	-	-					
Elmidae	-	-	15	5	7		90
Helodidae	-	-					
Hydrophilidae	-	-					
Dryopidae	-	-					
Amphizoidae	-	-					
Diptera	-	-					
Ceratopogonidae	-	-					
Chironomidae	-	-	22	5	4		103
Tanyderidae	-	-					
Psychodidae	-	-					
Rhagionidae	-	-					
Simuliidae	-	-					
Tabanidae	-	-					
Tipulidae	-	-		1			3
Anisopodidae	-	-					
Nematocera	-	-					
Brachycera	-	-					
Cyclorrhapha	-	-					
OTHER							
Hemiptera	-	-					
Notonectidae	-	-					
Hymenoptera	-	-					
Formicidae	-	-					
Lepidoptera	-	-					
Acarina	-	-	1		3		13
Oligochaeta	-	-					
Tubificidae	-	-					
Nematoda	-	-					
Hirudinea	-	-					
Gastropoda	-	-					
Total Number of Organisms							235
Total Number of Taxa			3	3	7		8

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 5
Date: **18/05/76**

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	15	88		4	4		222
Chloroperlidae	1	2			1		8
Nemouridae							
Perlidae							
Pteronarcidae		1					2
Perlodidae					3		6
Ephemeroptera	2	17			3		44
Baetidae	7	102	1	7	33		300
Behningiidae							
Ephemerellidae	16	63	4	2	21		212
Heptageniidae	12	131	2	8	16		338
Leptophlebiidae	17	10			6		66
Siphlonuridae							
Trichoptera		4					8
Brachycentridae							
Glossomatidae							
Hydropsychidae	2				3		10
Leptoceridae				1			2
Limnephilidae							
Phryganeidae							
Psychomyiidae							
Rhyacophilidae							
Coleoptera							
Haliplidae							
Chrysomelidae							
Curculionidae							
Dytiscidae							
Elmidae	35	165	7	12	13		464
Helodidae							
Hydrophilidae							
Dryopidae							
Amphizoidae							
Diptera							
Ceratopogonidae							
Chironomidae	218	359	30	28	134		1538
Tanyderidae							
Psychodidae							
Rhagionidae							
Simuliidae	3	1			1		10
Tabanidae							
Tipulidae		10	2		2		28
Anisopodidae							
Nematocera	4	3			3		20
Brachycera							
Cyclorrhapha							
OTHER							
Hemiptera							
Notonectidae							
Hymenoptera							
Formicidae							
Lepidoptera							
Acarina	8	104	8	3	6		258
Oligochaeta			2		1		6
Tubificidae							
Nematoda							
Hirudinea				1			2
Gastropoda							
Total Number of Organisms							3544
Total Number of Taxa	13	15	8	9	16		20

APPENDIX II MACROINVERTEBRATE SAMPLING ANALYSES

Substrate Type: **Multiple Plate**
Station No: 6
Date: 18/05/76

Invertebrate Identification List	Number of Organisms per 0.1 m^2 — Sample Number					Total (0.5 m^2)	Number of Organisms per m^2
	1	2	3	4	5		
Plecoptera	16		4	65	-		212
Chloroperlidae	1				-		2
Nemouridae	1				-		2
Perlidae		1		1	-		5
Pteronarcidae					-		
Perlodidae					-		
Ephemeroptera	2			36	-		95
Baetidae	5	1	4	42	-		130
Behnirgiidae					-		
Ephemerellidae	4		2	34	-		100
Heptageniidae	14	2	9	65	-		225
Leptophlebiidae				1	-		2
Siphlonuridae					-		
Trichoptera		1			-		2
Brachycentridae					-		
Glossomatidae					-		
Hydropsychidae	71	2	32	70	-		437
Leptoceridae					-		
Limnephilidae					-		
Phryganeidae					-		
Psychomyiidae					-		
Rhyacophilidae					-		
Coleoptera					-		
Haliplidae					-		
Chrysomelidae					-		
Curculionidae					-		
Dytiscidae					-		
Elmidae	51	67	110	109	-		842
Helodidae					-		
Hydrophilidae					-		
Dryopidae					-		
Amphizoidae					-		
Diptera					-		
Ceratopogonidae					-		
Chironomidae	121	40	171	218	-		1375
Tanyderidae					-		
Psychodidae					-		
Rhagionidae					-		
Simuliidae	1		1		-		5
Tabanidae					-		
Tipulidae	3	4	2	3	-		30
Anisopodidae					-		
Nematocera	2		5	1	-		20
Brachycera					-		
Cyclorrhapha					-		
OTHER							
Hemiptera					-		
Notonectidae					-		
Hymenoptera					-		
Furmicidae					-		
Lepidoptera					-		
Acarina	5	3	18	52	-		195
Oligochaeta					-		
Tubificidae					-		
Nematoda					-		
Hirudinea					-		
Gastropoda					-		
Total Number of Organisms							3679
Total Number of Taxa	14	9	11	13			17