T. W. BEAK CONSULTANTS LIMITED

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ENVIRONMENTAL SURVEY OF THE OTTAWA RIVER JULY, 1972

A Report For

ENVIRONMENT CANADA

OTTAWA, ONTARIO

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SUMMARY

Analysis and identification of the benthic fauna community in the study area has shown that the Ottawa River is most heavily affected by gross organic pollution at Cumberland Ferry, 15 miles downstream of Ottawa. From this point downstream the river undergoes a natural recovery, which is influenced more or less by the varying inputs of tributary streams and adjacent urban areas. Below Carillon dam, and just above Lake of Two Mountains, the river was only moderately affected by pollution. In Lake of Two Mountains, the Ottawa River attained its maximum recovery in the study, and could be characterized as affected by cultural eutrophication (enrichment) rather than gross organic pollution.

In Lake St. Louis, the input of Ottawa River water was affected both by St. Lawrence River water and runoff from Montreal urban areas, and as a consequence was considered more affected by cultural eutrophication than in Lake of Two Mountains.

Comparisons of the present data with those from the 1966/67 surveys revealed a general, slow and uniform degradation of environmental quality in the intervening time. This degradation could most aptly be described as cultural eutrophication or enrichment, resulting from the increasing urbanization and industrialization of the Ottawa River valley.

Water chemistry analyses in general were consistent with the above evaluation,

but did not elucidate any special problem parameters or areas. An indication of possible elevated phosphorous levels supported the diagnosis of cultural eutrophication.

PROJECT: T-3187

ENVIRONMENT CANADA
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INTRODUCTION

Environment Canada retained T. W. Beak Consultants Limited (Contract Number 01GRKW409-2-0087) to conduct a biological and chemical survey of the Ottawa River from Ottawa to Lake St. Louis at Montreal. The purpose of this investigation was to collect current data on bottom fauna and water chemistry to apply to an assessment of the present effects of pollution in the Ottawa River. Comparative background data was available from extensive and intensive studies conducted by BEAK during 1965, 1966, and 1967.

This previous programme, undertaken within the terms of a National Health Grant, was carried out as a research project of the Department of Entomology and Invertebrate Zoology, Royal Ontario Museum. The principal investigators were G. B. Wiggins, Curator of the Department, and T. W. Beak, Research Associate in the Department and President of T. W. Beak Consultants Limited. All the collected field material was deposited in the ROM as a permanently documented research collection. Portions of this collection have been used during the present project to provide the basis of an evaluation of changes in the pollutional status of the Ottawa River since the baseline surveys of 1966 and 1967. Summary sections of the report on that study are reproduced for reference in Appendix 3 of this report.

Previous pollution surveys of the Ottawa River have been conducted by Piche (1954), the Ontario Department of Health (1956), the Quebec Water Board (1967), and the Ontario Water Resources Commission and Quebec Water Board (1971, 1972).

The Ottawa River is the largest all-Canadian watershed in eastern Canada. The river runs 720 miles from the head of Lake Capimitchigama to its confluence with the St. Lawrence River at Lake St. Louis, and (via the des Prairies River) at Repentigny, draining an area of 56,000 square miles in eastern Ontario and western Quebec provinces. The mean annual flow is in excess of 70,000 cfs near the mouth. The topography of the drainage basin ranges from glaciated Pre-cambrian highlands upstream to sedimentary lowlands, formerly occupied by the Champlain Sea, in the downstream section. (OWRC/QWB, 1971)

The resources of the river are used extensively for recreation, domestic and industrial water supplies, domestic and industrial waste disposal, generation of hydro-electric power, and log driving and storage.

This report presents the results of a survey of approximately 80 miles of the downstream section of the Ottawa River from Cumberland Ferry to Lake St. Louis. Current data is compared to the baseline study prepared in 1966/67 to assess changes in environmental conditions.

GENERAL DISCUSSION

Most natural waters support in and on their bottom sediments, diverse communities of aquatic animals, collectively known as benthos. These are organisms such as segmented worms, clams, snails, insect larvae, and various small crustaceans. They exhibit varying degrees of sensitivity to adverse changes in water quality. Because of this, and the fact that such communities are relatively stable or undergo understandable natural fluctuations in composition, they can be used to measure pollution.

Clean waters normally support a large number of species of benthos but no superabundance of any one. Partial biological degradation by chemical or physical influences may kill or drive out the most sensitive species, while more tolerant forms may increase in numbers to occupy the vacated niches. Further impairment may result in a fauna restricted to very high numbers of only a few tolerant forms.

Total degradation results in elimination of even tolerant animals. For convenience, these three tolerance groups are usually defined as, respectively, Group 3 (sensitive), Group 2 (facultative), and Group 1 (tolerant). As conditions improve, either through effluent purification or natural recovery with increasing distance from the source, animals re-enter the environment in reverse order, the most sensitive last, until a normal balance in diversity and numbers is re-established.

In order to use the benthos to measure the impact of an effluent, it is preferable to document the animal communities prior to the onset of pollution. It is also desirable to establish unaffected controls in physically similar nearby areas, to monitor the natural seasonal and yearly variations of diversity and abundance, and to account for unforeseeable natural occurrences.

Field and laboratory procedures are presented in Appendix 1.

A technical discussion of results is presented in Appendix 2.

Excerpts from the previous report on the 1965, 1966, and 1967 surveys are contained in Appendix 3.

All sampling stations and locations are described in Table 1. Biological results appear in Table 2. Detailed identification results are presented in Table 3. Table 4 presents the water chemistry data.

Locations of the sampling stations and a summary of biological and water chemistry results are presented on a map of the study area.

DISCUSSION OF SURVEY DATA

Biological

The results of analysis and evaluation of biological samples have revealed a pattern of upstream pollution and downstream recovery in the Ottawa River study area. The Ottawa River was most affected by organic pollution at Station OR-25, 15 miles downstream of the Ottawa urban area. The silty bottom material contained bark and wood fibre. Organic pollution at this point was characterized by high abundance of oligochaete worms (sludgeworms) of a type associated in the literature with organically polluted sites. These worms comprised 90% of the fauna at this point. Pollution-sensitive aquatic insect forms were absent. The forms herein classified as facultative were not diverse and were dominated by species of chironomid (midge) larvae and fingernail clams, which are regarded as fairly tolerant. These results further indicated that pollution had increased since the baseline surveys of 1966 and 1967, when a more balanced community of animals was identified.

Downstream, at Station OR-15 near LeFaivre (Montebello), conditions were slightly improved from OR-25, but still organically polluted. Sediment consisted of soft grey silt with wood fibres and a foul odour. The fauna was more diverse than upstream, but still dominated by the oligochaete worms. The association of worms was considered less tolerant than that at the upstream station. No sensitive forms were collected. The facultative groups were more diverse than upstream and were dominated by the freshwater polychaete worms. Chironomid larvae and fingernail clams were also important. Since the baseline surveys of 1966 and 1967, the faunal diversity had decreased, and total abundance had increased, producing a more tolerant community, and indicating a slow degradation by organic pollution.

Station OR-13 was located in L'Orignal Bay, upstream of Hawkesbury. By this point the river was further recovered from the conditions upstream, but was considered to be mildly polluted. The fauna was still dominated by the oligochaetes, which nevertheless only comprised 50% of the total fauna. The oligochaete association resembled that at OR-15. A diverse fauna of facultative forms was collected, dominated by the fingernail clams. The chironomids were unusually absent. A single beetle larva, considered sensitive, was taken in the three grab hauls. Little change has occurred at this station since 1966/67. Diversity has decreased slightly, but abundance remained high. Sensitive forms (Trichoptera) which had been collected in previous years were not collected in 1972.

Recovery continued slowly at Station OR-9, upstream of Carillon dam, but conditions were still far from ideal. Oligochaetes were still dominant and very abundant, comprising 74% of the fauna numerically, but only 20% of the number of types identified in the detailed analysis. Pollution-sensitive forms were more abundant here than at any upstream location, and a diverse assemblage of facultative forms was collected. The detailed analysis revealed that conditions were slowly deteriorating at OR-9, and a more tolerant fauna was collected in 1972 than in 1966/67.

Recovery from upstream pollution was further evidenced at Station OR-1, below Carillon dam. Impoundment in the headpond, and subsequent turbulence on release, no doubt helped produce an improvement. Oligochaete worms comprised only 50% of the fauna, and both the sensitive and facultative groups were well represented. Detailed identification confirmed the recovery, with more sensitive associations of oligochaetes and chironomid larvae. Comparisons to previous data revealed that although conditions were better than at upstream stations, they were not as good as in previous years. The 1972 fauna was less diverse and abundant in all groups than that of 1966/67.

Station L2M2, in Lake of Two Mountains, revealed improved conditions from all upstream locations. Recovery was at a maximum at this location, although the environment was not fully recovered. The fauna was dominated by clams, including both the large, more sensitive unionids, and the small fingernail clams common upstream. Several groups of sensitive organisms were recovered, and the oligochaetes were present in a reasonable and low proportion to other forms. Data from previous surveys revealed that, while the environment was not grossly affected at this point, changes had occurred since 1966/67, which could best be attributed to enrichment, or cultural eutrophication. Total abundance had increased enormously since 1967, while diversity had remained approximately constant. These changes were most prominent among the facultative forms, for the sensitive species were less abundant in 1972, another indication of some degradation.

Station LL4, in Lake St. Louis off Pointe Claire, showed the effects of both mixing with St. Lawrence River water and pollution from the Montreal suburbs which border the lake. Water chemistry data revealed the slightly different nature of this water as compared to the Lake of Two Mountains. Biological data reflected this change in water quality and also the effects of urban drainage. Faunal composition was essentially similar to Station L2M2, but levels of abundance and diversity revealed a more degraded condition. Few sensitive forms were collected. The fauna was dominated by facultative forms, such as clams, chironomid larvae, and amphipods. Comparisons to data from 1966/67 showed a similar trend to that at L2M2, with changes in abundance characterized by fewer sensitive forms, and increases among facultative types. This indicated a cultural eutrophication from urban drainage on the north shore of the lake.

This results of this survey agree in general with those outlined by a more intensive survey conducted in 1968/69 by the Ontario Water Resource Commission and the Quebec Water Board (OWRC/QWB, 1971, 1972).

Since the OWRC/QWB stations were taken across the river and at both banks, while this survey was conducted mainly in midstream, the present data indicate total river quality rather than pinpointing specific waste sources and areas of degradation.

Water Chemistry

Results of water chemistry analysis did not, in general, elucidate specific areas of concern in the environmental degradation of the Ottawa River. Temperature, pH, and dissolved oxygen levels were very uniform. BOD analysis did not reveal any areas of special concern. Solids levels were reasonably consistent, increasing somewhat as the river flowed downstream, and being changed at LL4, presumably by the influence of St. Lawrence River water. Nutrient levels were not excessive, although the average Nitrogen/Phosphorus ratio (3.5:1) was low, indicating the possibility of excess phosphorus in the system, another possible indication of cultural eutrophication.

CONCLUSIONS

1. The Ottawa River, in the present study area, was most severely polluted upstream, at Station OR-25. The condition here may be described as organically polluted.

2. Downstream from Station OR-25, the river recovered, becoming gradually less polluted so that in Lake of Two Mountains it was reasonable to describe the water quality as eutrophic, but not polluted.

3. Station LL4, in Lake St. Louis, was affected both by St. Lawrence River water, and urban drainage from Montreal suburbs. While not polluted, this station showed evidence of increasing cultural eutrophication (enrichment) from urban drainage.

4. Comparisons to data of July, 1966 and 1967 surveys revealed that pollution problems have been increasing in the Ottawa River. All stations sampled were evaluated as having been degraded in the intervening five years.

5. Water chemistry parameters did not, in general, elucidate any special areas of concern. Increased total dissolved solids levels offered one indication of pollution load at some stations.

6. A low Nitrogen/Phosphorus ratio (3.5:1) indicated the possibility of increased phosphorus levels, an indication of cultural eutrophication.

RECOMMENDATIONS

1. Construction of modern treatment systems for all domestic and industrial waste discharges would alleviate the accelerating processes of eutrophication and degradation evident in the Ottawa River study area.

2. Particular attention should be paid to discharges of settleable solids, oxygen demanding dissolved solids, and nutrients.

3. Future surveys of a scope similar to the present study should be planned at 3 to 5 year intervals to document the future improvement or degradation in the Ottawa River environment.

4. Intensive surveys could pinpoint and assess the relative inputs of major pollution sources, and the efficiency of remedial measures.

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TABLES

TABLE 1

LOCATION OF SAMPLING STATIONS
OTTAWA RIVER - JULY, 1972

STATION	LATITUDE AND LONGITUDE	DESCRIPTION
OR/25	45°31'30"N 75°24'15"W	In Ottawa River about 1000 ft. downstream of Cumberland Ferry crossing, at approximately the Quebec/Ontario border line, i.e. about 800 ft. from Quebec bank and about 1600 ft. from Ontario bank. Depth about 25 ft.
OR/15	45°36'40"N 74°54' 3"W	In the deep water channel opposite Lefaivre in about 109 ft. of water approximately in mid-stream.
OR/13	45°38' 8"N 74°45'10"W	In the centre of l'Orignal Bay opposite Pointe au Chene on south side of channel and located between 2 black buoys and about 1000 ft. east of the upstream one in about 10 ft. of water.
OR/9	45°35'40"N 74°31'55"W	In the impoundment above the Carillon Dam about 7-1/2 miles west of the dam and approximately half way across the impoundment in about 45 ft. of water.
OR/1	45°29'10"N 74° 9'40"W	In Ottawa River about 5 miles west of its opening into Lake of Two Mountains. On north side of the channel opposite Batt. de Corbeau. When on station the white tower in the water and the church spire at St. Placide subtend an angle of 16°32'.
L2M2	45°25'37"N 74° 0'20"W	In Lake of Two Mountains on south side, about 500 ft. SE of Point Cadieux in about 15 ft. of water.
LL/4	45°25'37"N 73°49'26"W	In Lake St. Louis directly opposite and about 3500 ft. south of Pointe Claire. About 1000 ft. south of channel buoy No. 50S in about 20 ft. of water.

TABLE 2

BIOLOGICAL RESULTS
OTTAWA RIVER - JULY, 1972

STATION: OR/25 (3 July 1972)

SEDIMENT TYPE: Mud, silt, bark, wood fibre.

WATER DEPTH (ft.): 45

SAMPLE:	1	2*	3	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Ephemeroptera	-	-	-	-	-	0.3
Trichoptera	-	-	-	-	-	1.2
GROUP 2 ORGANISMS						
Chironomidae	5	6	4	9.4	7.7	5.2
Other Diptera	-	-	1	0.6	-	-
Pelecypoda	3	6	4	8.1	73.1	328.1
Gastropoda	2	2	-	2.5	97.5	48.5
Amphipoda	-	-	-	-	0.3	3.7
Isopoda	1	-	2	1.9	4.0	121.6
Turbellaria	-	-	-	-	-	4.0
Hirudinea	-	-	-	-	0.6	13.3
Polychaeta	-	-	-	-	-	4.6
GROUP 1 ORGANISMS						
Oligochaeta	191	74	111	235.0	591.0	556.2
TOTAL	202	88	122	257.5	774.4	1086.7
NO. OF TAXA	5	4	5	6	7	11
% Oligochaetes of Total				91.3	76.3	51.2

N.B. - 6 samples per station in 1966/67
3 samples per station in 1972

* Sample selected for detailed identification.

TABLE 2 (continued)

STATION: OR/15 (3 July 1972)

SEDIMENT TYPE: Soft grey mud, some wood fibre, foul odour.

WATER DEPTH (ft.): 60

SAMPLE:	1* **	2 **	3 **	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Trichoptera	-	-	-	-	1.5	-
GROUP 2 ORGANISMS						
Chironomidae	184	160	208	345.0	1.5	1.5
Pelecypoda						
(Unionidae)	-	1	-	0.6	-	-
(Sphaeriidae)	184	32	96	195.6	850.6	348.5
Gastropoda	16	-	-	10.0	5.2	9.6
Copepoda	-	-	-	-	-	0.3
Amphipoda	16	-	-	10.0	25.9	2.5
Isopoda	-	-	-	-	0.3	-
Turbellaria	-	-	-	-	4.6	0.6
Hirudinea	-	-	-	-	12.3	36.7
Nemata	8	-	-	5.0	-	-
Polychaeta	552	64	176	495.0	235.2	925.9
Statoblast	-	16	-	10.0	-	-
GROUP 1 ORGANISMS						
Oligochaeta	3800	3824	3120	6715.0	540.7	1475.6
TOTAL	4760	4097	3600	7786.2	1677.8	2801.2
NO. OF TAXA	7	5	4	8	10	9
% Oligochaetes of Total				86.2	32.2	52.7

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.
** Extrapolated numbers.

TABLE 2 (continued)

STATION: OR/13 (4 July 1972)

SEDIMENT TYPE: Soft brown mud.

WATER DEPTH (ft.): 15

SAMPLE:	1	2*	3 **	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Trichoptera	-	-	-	-	2.2	0.3
Coleoptera	1	-	-	0.6	-	-
GROUP 2 ORGANISMS						
Chironomidae	-	-	-	-	41.0	10.2
Pelecypoda	128	243	190	350.6	204.0	146.6
Gastropoda	4	6	26	22.5	1.2	5.9
Copepoda	-	-	-	-	-	9.0
Cladocera	-	-	-	-	-	0.3
Amphipoda	-	-	2	1.3	0.3	1.2
Insecta adult	-	1	-	0.6	-	-
Turbellaria	-	3	-	1.9	4.6	4.0
Hirudinea	-	-	2	1.3	4.0	23.2
Nemata	2	1	2	3.1	-	-
Nemertea	-	7	-	4.4	-	-
Hydrachnidae	-	-	-	-	-	0.3
Polychaeta	6	14	8	17.5	751.3	783.0
Egg mass indet.	4	-	-	2.5	-	-
GROUP 1 ORGANISMS						
Oligochaeta	70	229	480	486.9	1021.6	582.4
TOTAL	215	504	710	893.1	1850.8	1566.4
NO. OF TAXA	7	8	7	12	10	13
% Oligochaetes of Total				54.6	55.2	37.2

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.
** Extrapolated numbers.

TABLE 2 (continued)

STATION: OR/9 (4 July 1972)

SEDIMENT TYPE: Brown mud, sandy silt.

WATER DEPTH (ft.): 50

SAMPLE:	1*	2 **	3 **	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Ephemeroptera	-	-	-	-	-	0.3
Trichoptera	2	2	4	5.0	-	-
Coleoptera	-	-	-	-	-	0.3
GROUP 2 ORGANISMS						
Chironomidae	81	58	56	121.9	0.6	40.7
Pelecypoda	214	234	294	463.8	834.0	503.1
Gastropoda	3	10	8	13.1	53.1	42.6
Amphipoda	3	4	2	5.6	17.0	1.5
Isopoda	2	-	4	3.8	0.9	46.9
Turbellaria	-	-	-	-	2.5	96.3
Hirudinea	-	-	-	-	3.1	7.7
Nemata	3	4	-	4.4	-	-
Coelenterata	-	-	-	-	-	2.5
Polychaeta	7	6	-	8.1	103.1	59.3
GROUP 1 ORGANISMS						
Oligochaeta	965	1256	624	1778.1	957.4	1562.3
TOTAL	1280	1574	992	2403.8	1971.7	2363.5
NO. OF TAXA	9	8	7	9	9	12
% Oligochaetes of Total				74.0	48.6	66.1

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.
** Extrapolated numbers.

TABLE 2 (continued)

STATION: OR/1 (2 July 1972)

SEDIMENT TYPE: Soft brown mud.

WATER DEPTH (ft.): 18

SAMPLE:	1*	2	3	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Ephemeroptera	5	10	5	12.5	56.8	-
Trichoptera (Pupa)	2	-	1	1.9	0.3	-
GROUP 2 ORGANISMS						
Chironomidae	17	14	10	25.6	21.9	29.0
Other Diptera	-	-	1	0.6	-	-
Pelecypoda	1	6	-	4.4	28.7	39.5
Gastropoda	-	1	-	0.6	1.5	0.6
Amphipoda	3	-	-	1.9	6.2	0.9
Isopoda	-	-	-	-	4.6	1.9
Turbellaria	-	-	-	-	0.6	-
Hirudinea	-	-	-	-	0.9	0.3
Nemata	-	1	-	0.6	-	-
Hydrachnidae	-	-	-	-	-	0.3
Polychaeta	-	-	1	0.6	0.3	4.3
GROUP 1 ORGANISMS						
Oligochaeta	23	33	19	46.9	213.3	496.6
TOTAL	51	65	37	95.6	335.1	573.4
NO. OF TAXA	6	6	6	10	11	9
% Oligochaetes of Total				49.1	63.7	86.6

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.

TABLE 2 (continued)

STATION: L2M2 (2 July 1972)

SEDIMENT TYPE: Soft brown mud

WATER DEPTH (ft.): 20

SAMPLE:	1*	2 **	3 **	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Ephemeroptera	-	-	4	2.5	34.6	9.6
Trichoptera	2	2 (Pupa)	4	5.0	2.2	2.2
Coleoptera	-	-	-	-	0.3	-
Neuroptera	-	-	-	-	-	0.3
GROUP 2 ORGANISMS						
Chironomidae	11	16	16	26.9	7.7	13.0
Other Diptera	-	-	-	-	-	0.9
Pelecypoda	28	52	34	71.3	38.6	34.3
Gastropoda	2	4	2	5.0	3.4	4.3
Copepoda	-	-	-	-	-	0.3
Cladocera	-	-	-	-	-	0.6
Amphipoda	15	12	20	29.4	14.5	4.0
Isopoda	19	2	16	23.1	13.9	26.2
Turbellaria	-	2	2	2.5	0.9	-
Hirudinea	-	-	-	-	3.4	0.9
Egg mass indet.	-	-	2	1.3	-	-
GROUP 1 ORGANISMS						
Oligochaeta	7	12	12	19.4	26.2	3.4
TOTAL	84	102	112	186.3	145.7	100.0
NO. OF TAXA	7	8	10	10	12	13
% Oligochaetes of Total				10.4	18.0	3.4

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.
** Extrapolated numbers.

TABLE 2 (continued)

STATION: LL/4 (2 July 1972)

SEDIMENT TYPE: Sand, some mud.

WATER DEPTH (ft.): 25

SAMPLE:	1* **	2	3	Avg./ft.^{2} 1972	Avg./ft.^{2} 1967	Avg./ft.^{2} 1966
GROUP 3 ORGANISMS						
Ephemeroptera	-	-	-	-	8.6	0.9
Trichoptera	4	-	1	3.1	4.0	1.2
GROUP 2 ORGANISMS						
Chironomidae	24	1	1	16.3	51.9	43.2
Other Diptera	-	-	-	-	-	0.3
Pelecypoda	332	25	131	305.0	303.1	146.3
Gastropoda	244	6	69	199.4	5.9	4.3
Amphipoda	32	-	7	24.4	47.2	61.4
Isopoda	4	-	1	3.1	3.7	15.1
Turbellaria	4	1	1	3.8	2.2	7.1
Hirudinea	-	-	-	-	11.7	5.3
Nemata	2	-	-	1.3	-	-
Coelenterata	-	-	-	-	-	0.9
Hydrachnidae	2	-	-	1.3	-	-
Polychaeta	2	-	-	1.3	-	-
Egg mass indet.	40	-	-	25.0	-	-
GROUP 1 ORGANISMS						
Oligochaeta	62	11	11	52.5	300.0	91.4
TOTAL	752	44	222	636.3	738.3	377.5
NO. OF TAXA	12	5	8	12	10	12
% Oligochaetes of Total				8.3	40.6	24.2

N.B. - 6 samples per station in 1966/67.
3 samples per station in 1972.

* Sample selected for detailed identification.
** Extrapolated numbers.

TABLE 3

DETAILED IDENTIFICATION OF MACROINVERTEBRATES
OTTAWA RIVER - JULY, 1966, 1967, 1972

STATION:	OR/25			OR/15			OR/13		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 3 ORGANISMS									
TRICHOPTERA									
F. Leptoceridae									
Athripsodes sp.	-	-	2	-	-	-	-	-	-
Oecetis sp.	-	-	-	-	-	-	-	2	-
F. Polycentropodidae									
Phylocentropus sp.	-	-	-	-	3	-	-	-	-
GROUP 2 ORGANISMS									
TURBELLARIA									
O.Tricladida									
F.Planariidae									
Sp.indet.	-	-	6	-	1	1	-	3	-
O.Neorhabdocoela									
Sp.indet.	-	-	-	-	-	-	3	-	5
NEMERTEA									
Sp.indet.	-	-	1	-	2	9	-	4	-
NEMATA									
Sp.indet.	-	-	-	-	-	-	1	-	-
HIRUDINEA									
F. Erpobdellidae									
Sp.indet.	-	-	-	-	2	1	-	1	-
F. Glossiphoniidae									
Glossiphonia heteroclita	-	-	1	-	1	-	-	-	-
Helobdella stagnalis	-	1	1	-	9	24	-	-	21
Sp.indet.	-	-	-	-	-	-	-	2	-
F. Piscicolidae									
Sp.indet.	-	-	-	-	2	-	-	-	-
Sp. indet.	-	-	-	-	1	1	-	4	-

TABLE 3 (continued)

STATION:	OR/25			OR/15			OR/13		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 2 ORGANISMS (cont'd)									
POLYCHAETA									
Manayunkia speciosa	-	-	-	69	136	468	14	293	224
COPEPODA									
S.O. Cyclopoida									
Sp.indet.	-	-	-	-	-	1	-	-	2
ISOPODA									
F. Asellidae									
Asellus sp.	-	2	106	-	-	-	-	-	-
AMPHIPODA									
F. Gammaridae									
Gammarus sp.	-	-	-	-	-	1	-	-	-
Sp. indet.	-	-	-	-	3	2	-	-	-
F. Talitridae									
Hyallela azteca	-	-	-	-	-	1	-	-	-
Sp.indet.	-	-	1	2	1	-	-	-	-
CHIRONOMIDAE									
S.F. Tanypodinae									
Ablabesmyia sp.	-	-	-	-	1	-	-	-	-
Procladius sp.	-	1	-	19	1	1	-	43	1
S.F. Orthocladiinae									
Psectrocladius sp.	-	-	-	-	-	-	-	-	1
S.F. Chironominae									
Tribe Chironomini									
Chironomus sp.	1	-	-	4	-	-	-	-	-
Cryptochironomus sp.	-	1	-	-	-	-	-	-	-
Dicrotendipes sp.	-	1	-	-	-	-	-	-	-
Glyptotendipes sp.	-	1	-	-	-	-	-	-	-
Paracladopelma sp.	-	1	-	-	-	-	-	-	-
Polypedilum sp.	1	-	-	-	-	-	-	-	-
Tribelos/ Endochironomus sp.	4	2	-	-	-	-	-	-	-

TABLE 3 (continued)

STATION:	OR/25			OR/15			OR/13		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 2 ORGANISMS (cont'd)									
CHIRONOMIDAE (cont'd)									
Tribe Tanytarsini Sp. indet.	-	-	1	-	-	-	-	-	-
CERATOPOGONIDAE									
Sp. indet.	-	-	-	-	1	-	-	-	-
GASTROPODA									
S.O. Prosobranchiata									
F. Bulimidae									
Amnicola sp.	1	46	-	2	-	-	2	-	5
Bulimus sp.	-	-	4	-	-	-	-	-	-
Sp.indet.	1	2	-	-	-	-	-	-	-
F. Valvatidae									
Valvata sp.	-	-	-	-	1	5	2	-	-
F. Viviparidae									
Campeloma sp.	-	30	7	-	-	-	-	-	-
Sp. indet.	-	-	-	-	1	-	-	-	-
S.O. Pulmonata									
F. Lymnaeidae									
Lymnaea sp.	-	-	2	-	-	-	-	-	-
F. Physidae									
Physa sp.	-	-	5	-	1	-	1	-	-
F. Planorbidae									
Gyraulus sp.	-	-	-	-	-	-	1	-	-
Sp.indet.	-	-	5	-	-	-	-	-	-
PELECYPODA									
F. Sphaeriidae									
Pisidium sp.	6	49	41	14	86	52	114	58	62
Sphaerium sp.	-	-	29	4	90	99	107	2	-
Sp. indet.	-	22	1	4	289	76	20	13	15
F. Unionidae									
Eliptio sp.	-	-	-	-	-	-	-	1	-
Sp. indet.	-	-	-	1	-	-	-	-	-

TABLE 3 (continued)

STATION:	OR/25			OR/15			OR/13		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 1 ORGANISMS									
OLIGOCHAETA	74	238	206	475	660	1000+	229	683	420
F. Naididae									
Nais sp.	-	-	-	x	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	x	x	-	x
Stylaria fossularis	-	-	x	-	-	-	x	-	-
S. lacustris	-	-	x	-	-	x	-	-	-
Sp.indet.	-	-	-	x	-	-	-	-	x
F. Tubificidae									
Aulodrilus americanus	-	-	-	x	-	-	x	-	-
A. pigueti	-	-	-	x	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	x	-	x	x	-	-
Limnodrilus hoffmeisteri	x	x	x	x	-	x	x	x	-
L. profundicola	-	-	-	x	-	-	-	-	-
L. sp.	-	-	-	-	x	-	-	-	-
Peloscolex multisetosus	x	-	-	x	-	-	-	-	-
Immature Capilliform	x	-	x	-	-	x	x	x	-
Immature Non-Capilliform	x	x	x	x	x	x	x	x	x
Sp.indet.	-	x	-	-	-	-	-	-	-
TOTAL (Including Oligochaetes)	88	397	419	525	1291	1742+	480	1109	756
NO. OF TAXA	10	16	21	18	22	21	17	15	12
% Oligochaetes of Total	84.1	59.9	49.2	90.5	51.1	57.4	47.7	61.6	55.6

x Indicates presence.

TABLE 3 (continued)

STATION:	OR/9			OR/1			L2M2		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 3 ORGANISMS									
EPHEMEROPTERA									
F. Ephemeridae									
Hexagenia sp.	-	-	-	5	26	-	-	19	7
TRICHOPTERA									
F. Leptoceridae									
Oecetis sp.	1	-	-	-	-	-	-	-	1
Sp.indet.	-	-	-	2	-	-	-	-	-
F. Psychomyiidae									
Phylocentropus sp.	-	-	-	-	-	-	2	1	1
Sp. indet.	1	-	1*	-	-	-	-	-	-
GROUP 2 ORGANISMS									
COELENTERATA									
Sp.indet.	-	-	2	-	-	-	-	-	-
TURBELLARIA									
O. Tricladida									
F. Planariidae									
Sp.indet.	-	2	43	-	2	-	-	-	-
NEMERTEA									
Sp. indet.	-	3	-	-	-	-	-	-	-
NEMATA									
Sp. indet.	3	-	-	-	-	-	-	-	1
BRYOZOA									
Statoblast	-	-	-	1	-	-	-	-	-

* Exuvia

TABLE 3 (continued)

STATION:	OR/9			OR/1			L2M2		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 2 ORGANISMS (cont'd)									
HIRUDINEA									
F. Erpobdellidae									
Sp.indet.	-	2	6	-	-	1	-	-	1
F. Glossiphoniidae									
Glossiphonia heteroclita	-	-	-	-	-	-	-	-	1
Helobdella stagnalis	-	-	-	-	-	-	-	2	-
Sp.indet.	-	-	4	-	-	-	-	-	-
POLYCHAETA									
Manayunkia speciosa	7	148	133	-	-	6	-	-	-
OSTRACODA									
Sp. indet.	-	1	-	-	-	-	-	-	-
ISOPODA									
F. Asellidae									
Asellus sp.	2	3	76	-	3	1	19	14	8
Sp.indet.	-	-	5	-	-	-	-	-	-
AMPHIPODA									
F. Gammaridae									
Sp.indet.	3	21	1	3	1	-	15	5	2
CHIRONOMIDAE									
S.F. Tanypodinae									
Ablabesmyia sp.	3	-	-	1	-	-	-	1	-
Clinotanypus sp.	-	-	-	-	4	-	-	-	-
Coelotanypus sp.	6	-	-	13	-	4	2	1	5
Procladius sp.	66	-	8	-	4	14	7	-	2
S.F. Orthocladiinae									
Epoicocladius sp.	-	-	-	-	-	-	-	1	-
S.F. Chironominae									
Chironomus sp.	1	1	-	-	-	-	-	-	-
Cryptochironomus sp.	1	-	-	-	-	-	-	-	-

TABLE 3 (continued)

STATION:	OR/9			OR/1			L2M2		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 2 ORGANISMS (cont'd)									
CHIRONOMIDAE (cont'd)									
Paracladopelma sp.	1	-	-	-	1	-	-	-	-
Polypedilum sp.	1	-	-	1	5	-	1	-	-
Tribelos/Endo-chironomus sp.	1	-	-	-	-	-	-	-	-
Xenochironomus sp.	-	-	-	-	-	-	-	1	-
Sp. indet.	1	-	-	-	1 (Pupa)	-	1	1	-
CERATOPOGONIDAE									
Sp. indet.	-	-	-	-	-	-	-	-	2
GASTROPODA									
S.O. Prosobranchiata									
F. Bulimidae									
Amnicola sp.	2	6	3	-	1	-	-	-	2
Sp. indet.	-	-	-	-	-	-	-	1	-
F. Valvatidae									
Valvata sp.	1	26	-	-	-	-	-	-	-
Sp. indet.	-	-	-	-	-	-	2	-	-
S.O. Pulmonata									
F. Lymnaeidae									
Lymnaea sp.	-	3	-	-	-	-	-	-	-
F. Physidae									
Physa sp.	-	4	12	-	-	-	-	-	-
F. Planorbidae									
Promenetus sp.	-	-	-	-	-	-	-	-	3
Sp. indet.	-	1	-	-	-	-	-	-	-
Sp. Indet.	-	2	-	-	-	-	-	-	-
PELECYPODA									
F. Sphaeriidae									
Pisidium sp.	92	185	136	-	9	28	3	4	4
Sphaerium sp.	113	79	257	-	-	-	5	8	1
Sp. indet.	9	300	13	-	2	-	3	2	2
F. Unionidae									
Eliptio sp.	-	-	-	1	-	-	16	-	-
Ligumia/Micromya sp.	-	-	-	-	2	-	-	6	5
Sp. indet.	-	-	-	-	-	1	1	-	-

TABLE 3 (continued)

STATION:	OR/9			OR/1			L2M2		
DATE:	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966	July 1972	July 1967	June/ July 1966
GROUP 1 ORGANISMS									
OLIGOCHAETA	965	577	912	23	93	241	7	20	-
F. Lumbriculidae									
Stylodrilus heringianus	x	-	x	-	-	-	-	-	-
Sp. indet.	-	x	-	-	-	-	-	-	-
F. Naididae									
Slavina appendiculata	-	-	x	-	-	-	-	-	-
Stylaria fossularis	-	-	x	x	-	-	-	-	-
S. lacustris	-	-	x	-	-	-	-	-	-
Stylaria sp.	-	-	-	-	-	-	x	-	-
Sp. indet.	-	-	x	-	-	-	-	-	-
F. Tubificidae									
Aulodrilus americanus	-	-	-	-	-	-	x	x	-
Limnodrilus hoffmeisteri	x	x	x	x	x	x	x	-	-
L. sp.	-	-	-	x	-	x	-	-	-
Peloscolex multisetosus	x	-	-	-	-	-	-	-	-
P. sp.	-	x	x	-	-	-	-	-	-
Immature Capilliform	x	x	-	-	-	-	-	-	-
Immature Non-Capilliform	x	x	x	x	x	x	-	x	-
F. Lumbricidae									
Sp. indet.	-	-	-	-	-	-	-	x	-
TOTAL (Including Oligochaetes)	1270	1364	1612	50	154	296	84	87	48
NO. OF TAXA	25	22	23	12	15	10	16	18	17
% Oligochaetes of Total	76.0	42.3	56.6	46.0	60.4	81.4	8.3	23.0	0

x Indicates presence.

TABLE 3 (continued)

STATION:	LL/4		
DATE:	July 1972	July 1967	June/July 1966
GROUP 3 ORGANISMS			
EPHEMEROPTERA			
F. Ephemeridae			
Hexagenia sp.	-	8	1
TRICHOPTERA			
F. Leptoceridae			
Athripsodes sp.	1	1	1
F. Polycentropodidae			
Phylocentropus sp.	-	4	-
Sp. indet.	1	-	-
GROUP 2 ORGANISMS			
COELENTERATA			
Hydra sp.	-	-	1
TURBELLARIA			
O. Tricladida			
F. Planariidae			
Sp. indet.	2	2	4
NEMATA	-	-	2
HIRUDINEA			
F. Glossiphoniidae			
Glossiphonia heteroclita	-	1	9
Helobdella stagnalis	-	8	-
POLYCHAETA			
Manayunkia speciosa	1	-	-
ISOPODA			
F. Asellidae			
Asellus sp.	1	5	14
Lirceus sp.	1	-	-

TABLE 3 (continued)

STATION:	LL/4		
DATE:	July 1972	July 1967	June/July 1966
GROUP 2 ORGANISMS (cont'd)			
AMPHIPODA			
F. Gammaridae			
Gammarus sp.	9	25	-
Gammarus or Crangonyx sp.	7	-	-
Sp. indet.	-	-	30
Sp. indet.	-	-	2
HYDRACARINA			
Sp. indet.	1	-	-
CHIRONOMIDAE			
S.F. Tanypodinae			
Ablabesmyia sp.	1	2	-
Coelotanypus sp.	3	-	2
Conchapelopia / Arctopelopia sp.	-	-	1
Procladius sp.	1	6	2
S.F. Chironominae			
Tribe Chironomini			
Chironomus sp.	2	21	4
Cryptochironomus sp.	2	-	-
Paracladopelma sp.	-	-	2
Polypedilum sp.	1	4	4
Stictochironomus sp.	1	-	-
Tribelos/Endochironomus sp.	1	-	2
Tribe Tanytarsini			
Microtendipes sp.	-	1	1
Tanytarsus sp.	-	-	1
GASTROPODA			
S.O. Prosobranchiata			
F. Bulimidae			
Bulimus sp.	110	2	3
S.O. Pulmonata			
F. Lymnaeidae			
Sp. indet.	1	-	-

TABLE 3 (continued)

STATION:	LL/4		
DATE:	July 1972	July 1967	June/July 1966
GROUP 2 ORGANISMS			
GASTROPODA (cont'd)			
F. Physidae			
Physa sp.	-	-	1
F. Planorbidae			
Sp. indet.	2	-	-
PELECYPODA			
F. Sphaeriidae			
Pisidium sp.	4	-	3
Sphaerium sp.	161	142	40
Sp. indet.	-	-	4
F. Unionidae			
Eliptio sp.	1	-	-
Lampsilis sp.	-	-	1
Ligumia/Micromya sp.	-	8	5
Sp. indet.	1	-	-
GROUP 1 ORGANISMS			
OLIGOCHAETA	31	156	66
F. Naididae			
Nais sp.	-	-	x
F. Tubificidae			
Aulodrilus americanus	-	x	-
Limnodrilus hoffmeisteri	-	x	x
L. sp.	-	-	x
Peloscolex sp.	x	-	-
Potamothrix vejdovskyi	x	-	-
Immature Non-Capilliform	x	x	x
TOTAL (Including Oligochaetes)	346	396	207
NO. OF TAXA	28	19	29
% Oligochaetes of Total	9.0	39.4	31.9

x Indicates presence.

TABLE 4

RESULTS OF WATER CHEMISTRY ANALYSIS
OTTAWA RIVER - JULY, 1972

STATION:	OR/25		OR/15		OR/13	
DATE:	3 July 1972		3 July 1972		4 July 1972	
DEPTH (ft.):	0	45	0	60	0	15
Temperature (°C)	19.8	19.0	19.5	18.5	20.0	19.5
pH	6.9	6.9	6.9	7.0	7.0	6.9
Dissolved Oxygen						
% Saturation	100	98	99	106	104	100
ppm	8.8	8.8	8.8	9.8	9.4	8.8
BOD_5	0.5	0.3	0.8	0.5	0.6	0.5
Suspended Solids	2.4	2.4	4.8	6.4	1.6	3.6
Suspended Solids - Ash	<1.0	0.4	3.2	3.6	<1.0	0.8
Dissolved Solids	53.6	36.6	55.2	67.6	73.4	100.5
Dissolved Solids - Ash	12.0	15.6	41.8	30.4	71.0	89.2
Total Solids	56.0	39.0	60.0	74.0	75.0	104.0
Total Solids - Ash	12.0	16.0	45.0	34.0	71.0	90.0
Colour (Co-Pt)	40	40	40	40	40	40
Nitrate Nitrogen	0.07	0.05	0.06	0.13	0.06	0.17
Ortho-Phosphate Phosphorus	0.02	0.04	0.06	0.09	0.04	0.05

All results expressed as ppm unless otherwise indicated, and excepting pH.

TABLE 4 (continued)

STATION:	OR/9		OR/1	
DATE:	4 July 1972		2 July 1972	
DEPTH (ft.):	0	50	0	18
Temperature (°C)	19.5	19.0	20.5	20.0
pH	6.9	6.9	7.0	6.9
Dissolved Oxygen				
% Saturation	110	104	92	89
ppm	9.8	9.5	8.1	7.9
BOD_5	0.3	0.5	0.3	0.3
Suspended Solids	4.0	0.4	6.4	18.4
Suspended Solids - Ash	0.9	<1.0	3.6	15.6
Dissolved Solids	60.0	72.6	54.6	56.6
Dissolved Solids - Ash	49.1	43.0	23.4	53.4
Total Solids	64.0	73.0	61.0	75.0
Total Solids - Ash	50.0	43.0	27.0	69.0
Colour (Co-Pt)	40	40	40	50
Nitrate Nitrogen	0.09	0.13	0.10	0.23
Ortho-Phosphate Phosphorus	0.05	0.10	0.10	0.10

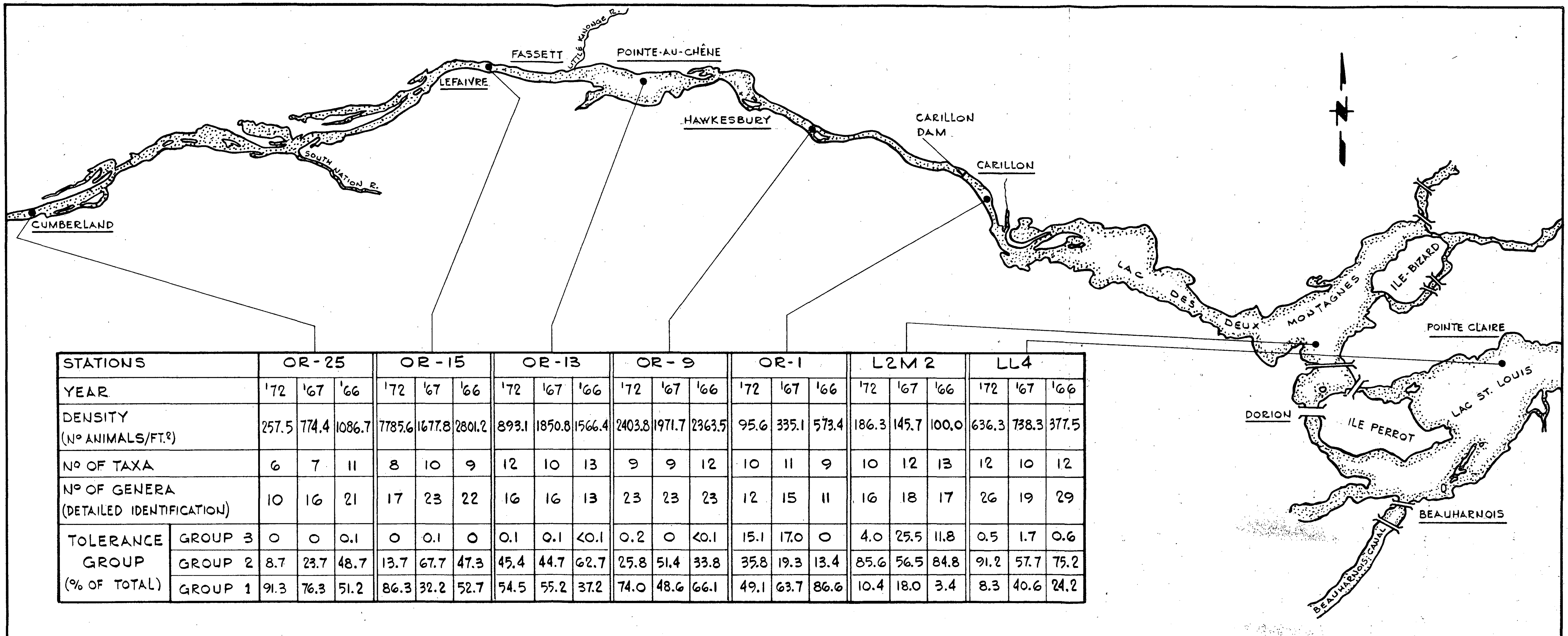
All results expressed as ppm unless otherwise indicated, and excepting pH.

TABLE 4 (continued)

STATION:	L2M2		LL/4	
DATE:	2 July 1972		2 July 1972	
DEPTH (ft.):	0	20	0	25
Temperature (°C)	21.0	20.0	21.0	18.0
pH	7.0	7.1	7.1	7.7
Dissolved Oxygen				
% Saturation	102	98	100	95
ppm	9.0	8.7	8.7	8.7
BOD_5	0.6	0.7	0.3	0.1
Suspended Solids	2.8	2.8	2.8	6.8
Suspended Solids - Ash	<1.0	0.4	1.6	2.8
Dissolved Solids	108.2	64.2	127.2	150.2
Dissolved Solids - Ash	50.0	20.6	81.4	97.2
Total Solids	111.0	67.0	130.0	157.0
Total Solids - Ash	50.0	21.0	83.0	100.0
Colour (Co-Pt)	40	40	35	20
Nitrate Nitrogen	0.13	0.14	0.09	0.06
Ortho-Phosphate Phosphorus	0.06	0.04	0.08	0.07

All results expressed as ppm unless otherwise indicated, and excepting pH.

DRAWING



STATIONS		OR-25			OR-15			OR-13			OR-9			OR-1			L2M2			LL4		
YEAR		'72	'67	'66	'72	'67	'66	'72	'67	'66	'72	'67	'66	'72	'67	'66	'72	'67	'66	'72	'67	'66
DENSITY (N° ANIMALS/FT.^{2})		257.5	774.4	1086.7	7785.6	1677.8	2801.2	893.1	1850.8	1566.4	2403.8	1971.7	2363.5	95.6	335.1	573.4	186.3	145.7	100.0	636.3	738.3	377.5
N° OF TAXA		6	7	11	8	10	9	12	10	13	9	9	12	10	11	9	10	12	13	12	10	12
N° OF GENERA (DETAILED IDENTIFICATION)		10	16	21	17	23	22	16	16	13	23	23	23	12	15	11	16	18	17	26	19	29
TOLERANCE GROUP (% OF TOTAL)	GROUP 3	0	0	0.1	0	0.1	0	0.1	0.1	<0.1	0.2	0	<0.1	15.1	17.0	0	4.0	25.5	11.8	0.5	1.7	0.6
	GROUP 2	8.7	23.7	48.7	13.7	67.7	47.3	45.4	44.7	62.7	25.8	51.4	33.8	35.8	19.3	13.4	85.6	56.5	84.8	91.2	57.7	75.2
	GROUP 1	91.3	76.3	51.2	86.3	32.2	52.7	54.5	55.2	37.2	74.0	48.6	66.1	49.1	63.7	86.6	10.4	18.0	3.4	8.3	40.6	24.2

LOCATION OF SAMPLING STATIONS
JULY SURVEYS — OTTAWA RIVER

5 0 5 10
SCALE IN MILES

ENVIRONMENT CANADA
OTTAWA — ONTARIO

BEAK

DATE	13-2-73
PROJECT	T3187
DWG. NO.	B3187-1

APPENDIX 1

APPENDIX 1

FIELD AND LABORATORY PROCEDURES

PROJECT: T-3187

ENVIRONMENT CANADA
OTTAWA, ONTARIO

ENVIRONMENTAL SURVEY OF THE OTTAWA RIVER - JULY, 1972

DATE: APRIL, 1973

APPENDIX 1

FIELD AND LABORATORY PROCEDURES

FIELD PROCEDURES

A biological survey of bottom-dwelling invertebrate animals was made on 2-4 July 1972. Field work was performed by Mr. L. Anthony, Biologist, aided by Mr. R. Dalrymple, Technician. BEAK provided all necessary field equipment, and land and water transportation.

Seven locations were sampled, as described in Table 1 and illustrated in Drawing B-3187-1. These were the same locations sampled in the July, 1966 and 1967 surveys.

Three replicate bottom samples were obtained at each station by means of a Ponar grab. This clam-shell type device cuts out, in each haul, 0.54 sq.ft. of bottom area to a depth of 2 to 6 inches depending on sediment texture. Each Ponar grab sample was screen-washed through a 30-mesh per inch standard sieve screen to remove extraneous mud and silt. The residue was preserved in 5% buffered formalin in labelled containers, and forwarded to the BEAK laboratory for subsequent analysis.

Water samples were obtained from surface and bottom water layers at each station using a Van Dorn sampler. For each depth and location, two one-litre samples were frozen for later determination of BOD_5, total and suspended solids plus ash, colour, and pH. In addition, a one-half litre sample was fixed with chloroform to preserve it for analysis of nitrates and phosphates.

Temperature and dissolved oxygen were determined in situ with an E.I.L. dissolved oxygen/temperature meter, Model 15A.

LABORATORY PROCEDURES

All benthic macroinvertebrates were picked manually from the screen-washed residue, sorted into major taxonomic groups (biological classifications), and counted. The results of these analyses are presented in Table 2. In addition, the total number of organisms per sample, the number of taxa (taxonomical groupings) per sample, plus the density (per square foot) for each taxa, was calculated and included in Table 2. Summary data from the 1966 and 1967 surveys also appears in this table, and a summary of all biological data appears on drawing B-3187-1.

One representative sample from each set of three replicates was chosen for detailed analysis. A representative sample was one which contained an adequate cross-section of organisms in terms of taxonomic diversity and total numbers present. This analysis demands special techniques, such as detailed examination of fine structures under a binocular microscope, and dissection and slide-mounting of certain parts of some specimens for examination with a compound microscope. Representative oligochaete worm and chironomid larvae were specially prepared and permanently mounted on slides in Turtox CMC-10 medium for microscopical examination. Animals were identified to the highest practical taxonomic level, ideally to species. This analysis was also performed on one sample per station for each of the July 1966 and 1967 surveys. The results of these analyses are presented in Table 3.

All water chemistry samples were analyzed in the BEAK laboratory strictly according to American Public Health Association 'Standard Methods' (A.P.H.A., 1971). Analyses were made for pH, BOD_5, colour, total and suspended solids plus ash, nitrate and ortho phosphate. Table 4 presents the water chemistry analyses. This data is summarized in Drawing B-3187-1.

APPENDIX 2

APPENDIX 2

TECHNICAL DISCUSSION

APPENDIX 2

TECHNICAL DISCUSSION

BIOLOGICAL

Station OR-25 is located near Cumberland Ferry, approximately 15 miles downstream of Ottawa. Bottom sediments were silty with bark and wood fibre. The benthic fauna at this location was characterized by a dominance of oligochaetes, which constituted about 90% of the population numerically. Goodnight and Whitley (1960) considered such a figure to represent heavy pollution. Detailed identification of these worms revealed the species *Limnodrilus hoffmeisteri* and *Peloscolex* (prob. *multisetosus*), an association which has been identified from organically polluted situations elsewhere in the lower St. Lawrence drainage (Brinkhurst et al, 1968; Brinkhurst, 1967). Pollution-sensitive species (Group 3) were absent from the present collections.

The organisms considered facultative towards pollution (Group 2) were dominated by the Chironomidae (midge larvae) and the Pelecypoda (mainly Sphaeriidae - fingernail clams). The other forms present, including Gastropoda (snails), Isopoda (aquatic sowbugs), and other Diptera (flies), were not abundant. The detailed identification revealed that generic diversity among these groups was very low, and while the general tabulations (Table 2) listed 6 taxa, these contained only 10 genera, of which four were oligochaetes, in the detailed identification (Table 3).

Comparison to previous results indicated an increased pollution load. Detailed identification of the sphaeriid clams revealed that only Pisidium was collected in 1967 and 1972. This species has been characterized as more tolerant of organic pollution than Sphaerium (Ingram et al, 1963), which was found at all the downstream stations. Gill-breathing snails, abundant in 1967, were scarce in 1972. Several facultative chironomids, such as Dicrotendipes and Glyptotendipes, were found in 1967 but not 1972.

Some other considerations in a worsening environmental picture were the general increase in the proportion of oligochaetes in the samples, and a general decrease in total abundance and diversity of the fauna since 1966.

The water chemistry data did not reveal any definite sources of concern.

Station OR-15, at Lefaivre (Montebello), presented a slightly improved situation to that at OR-25, indicating some degree of recovery in this section. The benthic fauna was both more diverse and more abundant, in a very similar substrate of silt with some wood fibre. Oligochaetes comprised approximately 85% of the fauna numerically, and 50% of the taxa identified. This oligochaete fauna was more diverse than that at OR-25, comprising 9 types in an association which has been termed typical of eutrophic sites (Brinkhurst et al, 1968).

Pollution-sensitive organisms were not recorded at this location. The other forms included a diverse assemblage of facultative forms, dominated by the Polychaeta, Chironomidae, and Pelecypoda (Sphaeriidae). There was very little generic diversity among these forms. The freshwater polychaete, Manayunkia speciosa, is apparently tolerant of mildly polluted habitats, although few specific ecological studies of the organism have appeared in the literature.

Since the baseline surveys, generic diversity has decreased among forms other than oligochaetes, and the percentage of oligochaetes in the total fauna, and density of the total fauna has risen sharply. Very few of the facultative Group 2 forms recorded in 1966/67 were found in 1972, and there were lower abundances of those forms still present. These data presented a picture of worsening conditions, presumably increasing organic pollution, in a benthic environment already moderately polluted. This situation is more degraded than in 1966/67, and is apparently being degraded faster than at Station OR-25.

The water chemistry data indicated that volatile dissolved solids may be implicated in the deterioration at this station.

Station OR-13 is located in L'Orignal Bay, upstream of Hawkesbury, Ontario. Bottom sediments were brown silty ooze, with no wood fibre noted. The fauna at this station was dominated by Oligochaeta, although the Pelecypoda (Sphaeriidae) were also very abundant, and the oligochaetes comprised only about 50% of the fauna numerically. A diverse assemblage of facultative forms was identified, as well as a single Coleoptera (beetle) adult, considered relatively sensitive. The usually abundant chironomid larvae were notably absent during this sampling.

Comparison to previous surveys revealed that little change had occurred since 1966/67. Total abundance had decreased, but the diversity had remained high. Changes included the lack of Trichoptera (caddisfly larvae) in 1972, and the disappearance of the Chironomidae. This was the only sampling location at which chironomids were not found. Detailed identification revealed that the oligochaete fauna was diverse, and resembled that at Station OR-15, typified as eutrophic. The environmental situation at this location has apparently been slowly and continuously degraded (by eutrophication), although conditions are superior here to the two upstream locations.

Water chemistry data revealed that dissolved solids were at their highest levels at this station.

Station OR-9 is downstream of Hawkesbury and upstream of Carillon dam, with a sandy-silt bottom type. The dominant benthic forms recorded at this location were the oligochaetes, which comprised 74% of the fauna numerically, but only about 20% taxonomically. Pollution-sensitive Group 3 organisms were more abundant at this location than at any upstream station, although this had not been the case in previous surveys. A diverse collection of facultative Group 2 forms was dominated by the sphaeriid clams, and chironomid larvae were also abundant.

Detailed identification revealed that the majority of groups were less abundant and diverse than in previous years, with the oligochaetes, chironomid larvae, and sphaeriid clams filling the voids. The oligochaete fauna would best be classified as characteristic of eutrophy, with Limnodrilus hoffmeisteri, and Peloscolex sp. (poss. ferox) found with Stylodrilus heringianus, usually considered typical of more oligotrophic situations. This fauna had changed radically from 1966, when several species of more intolerant Naididae were identified. The rich chironomid fauna may also be characterized as a tolerant group, with such species as Chironomus, Cryptochironomus, and Procladius, being prominent.

Conditions at this point showed a degree of improvement over the three upstream stations, but not full recovery. Degradation appeared to be ongoing here at a slow, steady rate, as characterized by the changes in facultative fauna, the present large community of oligochaetes and chironomids, the increasing proportions of oligochaetes in the fauna, and the increasing total fauna abundance, with little change in taxonomic diversity.

Station OR-1 was located below Carillon dam, near where the Ottawa River enters Lake of Two Mountains. The fauna in the brown ooze at this point was dominated by oligochaete worms, comprising 50% of the total abundance and less than 50% of the taxonomic diversity. There was a variety of facultative forms and good representation of the sensitive Group 3 organisms. The facultative forms were dominated by the chironomid larvae. Although the diversity at this station was comparable to those upstream, the total abundance was much lower (95.6/ft.^{2} vs 2403.8/ft.^{2} at OR-9).

The detailed identification confirmed that much recovery had occurred at this station as compared to upstream locations. The mayfly nymph Hexagenia sp., a clean water form, was present at 12.5/ft.^{2}, and some Trichoptera pupae were also identified. These forms had been found in the July, 1967, survey as well.

The oligochaete fauna could be described as mesotrophic, containing Stylaria fossularis, a naidid, as well as the tubificid Limnodrilus hoffmeisteri. The chironomid fauna was similarly classified, with Polypedilum, Coelotanypus, and Ablabesmyia.

Comparison to previous results revealed that conditions were not as good in

1972 as they had been in 1966/67, with lower total abundance, and much lower abundances of Ephemeroptera, Pelecypoda, Amphipoda, Isopoda, and Oligochaeta. These data indicated a good degree of recovery from pollution above the Carillon dam, but also that the effects of organic pollution were being lightly felt at this point. Recovery was probably aided by the water impoundment and subsequent turbulent release at Carillon dam.

One pollution indication from the water chemistry data was that the highest values for colour, and nitrates were found in the bottom water sample at Station OR-1.

Station L2M2 was located in Lake of Two Mountains, off Cadieux Point. Conditions here were improved over those of OR-1, and revealed the maximum degree of recovery identified in this survey. The fauna was dominated by the clams, including both the large, more-sensitive unionids, and the small sphaeriids. Chironomid larvae, amphipods, and isopods, were also well represented. Sensitive forms were present in both the Ephemeroptera and Trichoptera. The oligochaetes were present in proportion to other major components of the benthos, comprising 10% of the abundance, and 20% of the diversity.

Detailed identifications revealed that the oligochaete fauna could be considered mesotrophic, containing *Aulodrilus americanus* and *Stylaria*, as well as the cosmopolitan *Limnodrilus hoffmeisteri*. The chironomid fauna was similarly characterized by *Coelontanypus*, *Polypedilum*, and *Procladius*. The sensitive mayfly *Hexagenia* sp. was abundant.

Comparison to the 1966/67 surveys confirmed that the environment at Station

L2M2 was not grossly polluted, and possibly undergoing a slow eutrophication. Generally, the total abundance of animals has been increasing, while the diversity has remained essentially constant. This increase of abundance has been most pronounced among the facultative groups, while the sensitive forms were not as abundant in 1972 as in 1967 or 1966. Such trends would be expected where nutrient enrichment leads to increased productivity, but less stable conditions.

Station LL4 was in Lake St. Louis off Pointe Claire. At this station, the water mass was apparently predominantly of Ottawa River origin. Some mixing with St. Lawrence flow may be evidenced by the higher dissolved solids levels and lower colour, although this may also be partly attributable to drainage from the urban communities on the adjacent south shore of Montreal Island.

The benthic fauna at LL4 was similar in composition to that at L2M2, but the levels of abundance revealed a more degraded condition. The dominant organisms were sphaeriid and unionid clams, although the Gastropoda (snails) were also abundant. A diverse assemblage of other facultative forms was found in lesser numbers, with the chironomids and amphipods strongly represented. The oligochaetes were present in reasonable proportion, composing 8.3% of the total abundance and about 15% of the diversity. Sensitive Trichoptera larvae were present.

The detailed identifications revealed a eutrophic situation, with the oligochaetes Peloscolex sp. and Potamothrix vejdovskyi, unionid clams, and chironomids such as Ablabesmyia, Coelotanypus, Stictochironomus, and Tribelos/Endochironomus. The gastropods were mainly the gill-breathing prosobranch, Bulimus sp.

Comparison with past surveys indicated that little change in faunal composition had occurred, but the abundances of some groups had changed, with a decrease of sensitive forms, and increases among facultative types, especially clams and snails.

The environmental situation may be typified as eutrophic. Under the influence of urban drainage on the north shore, slowly increasing cultural eutrophication may be expected to further change the conditions at this station, as it appeared to be doing in the whole Ottawa River valley.

The results of this survey agree generally with the findings of the more extensive 1968/69 Ontario Water Resources Commission-Quebec Water Board study (OWRC/QWB 1971, 1972). That survey sampled sites across the river and adjacent to the shorelines, while the present work concerns mid-stream stations which give a more balanced picture of overall river quality rather than pinpointing specific problem areas.

WATER CHEMISTRY

Results of chemical analyses of samples of surface and bottom waters are presented in Table 4. Some reference to these parameters has been made when necessary in the above discussion of biological results.

Water chemistry parameters did not in general elucidate the causes of environmental degradation obvious in the biological results. Temperature was reasonably constant, generally cooler at depth, and warmer downstream, as one would expect. The pH was very uniform, except at Station LL4 where the effects of the St. Lawrence River may be felt. Dissolved oxygen and BOD_5 values did not reveal any serious problem areas, with the lowest D.O. values recorded at

Station OR-1, where the biological results were good. Solids levels were also reasonably stable, increasing somewhat downstream, and especially at LL4 as noted above. Nutrients, as represented by NO_3 and PO_4, were not overly abundant, although the N/P ratio (about 3.5:1) was low as compared to "favourable" levels (FWPCA, 1968), and indicated a possible excess of phosphorus. This is another indication of possible enrichment or cultural eutrophication.

DIVERSITY INDEX

The diversity index ($\bar{d}$) had been proposed as a possible treatment for the data of this survey and an evaluation of environmental conditions. However, it has not been possible to process the data in the form necessary for successful calculation of diversity index.

Diversity index has been recognized by many as a useful way of characterizing the results of biological surveys in relation to pollution detection, (Wilhm, 1967, Wilhm and Dorris, 1968). This index, derived from information theory is calculated from the equation $\bar{d} = -\sum n_i/N \log_2 n_i/N$. The result is a function of the number of species present and the evenness with which the individuals are distributed among the species. The index as such is dimensionless, and the formula may be completed using biomass, or energy units as well as numbers. Although widely used in pollution studies (Patten, 1962, Wilhm and Dorris, 1966), the diversity index also has its critics (Hurlburt, 1971).

When used with numbers, it is important that the whole benthic community be identified to a comparable level at every location considered. No lumping or splitting of taxa should be permitted, and all animals must be counted and their counts assigned to groups.

Herein lies the problem with the present work. Oligochaete worms may, at some stations, constitute 70-90% of the fauna numerically, and over half of the fauna taxonomically. The large numbers of individuals, the difficulty of sorting the individuals into species and the difficulty of characterizing and identifying species, especially in the presence of immature specimens, forces investigators to identify only a small proportion of the total worm fauna. This affords one a knowledge of species composition, but no knowledge of the actual numbers of each species present in the association. In this case, the oligochaetes must be deleted from the calculation of diversity index, which may severely bias the result.

Numbers of other animals in the samples could be used to obtain index values which, when used in the proper context, could be useful in data assessment. However, in many cases, due to the nature and background of taxonomic work, individuals cannot be positively identified. They may be damaged specimens, juveniles, or incompletely described forms. These individuals are assigned to a "species indeterminate" (sp.indet.) category in the tables, which may then contain counts of several species, and of species identified elsewhere in the study. Again, the diversity index becomes biased, and the value may be either higher or lower than it should be.

In considering the problems involved in calculating an unbiased diversity index, and the difficulty in interpreting a biased result, it was decided not to use this index at this time as a basis of evaluation of environmental conditions.

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APPENDIX 3

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EXCERPTS FROM:

"EXTENSIVE AND INTENSIVE STUDIES OF THE BENTHIC MACRO-INVERTEBRATE FAUNA

OF THE ST. LAWRENCE AND OTTAWA RIVERS

WITH PARTICULAR REFERENCE TO WATER POLLUTION".

(Report on 1965, 1966, and 1967 Surveys)

PROJECT: T-3187

ENVIRONMENT CANADA
OTTAWA, ONTARIO

ENVIRONMENTAL SURVEY OF THE
OTTAWA RIVER - JULY, 1972

DATE: APRIL, 1973

APPENDIX 3

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This study of the St. Lawrence River from Kingston, Ontario, to Lake St. Louis, and of the Ottawa River from Ottawa to Lake St. Louis, extended over the three years 1965, 1966 and 1967. It consisted of extensive and intensive sampling of the benthic macro-invertebrate fauna with some auxiliary chemical sampling. More comprehensive chemical data on the same sections of river are available from other sources.

The purposes of the survey were as follows:-

1. To establish a well-documented baseline of the faunistic characteristics of the waters with particular reference to water pollution;

2. To make these data available in such form that it can be used at any future date to measure trends in water pollution in these waters;

3. To develop methods of presentation and analysis of benthic macro-invertebrate data in a form suitable for measurement of water pollution;

4. To establish a research collection of benthic material permanently stored in a public museum where it can be used for future reference and research.

These purposes were achieved by means of a three year sampling programme in which all samples were sorted, the animals classified to families and counted. All specimens were then stored in a special research collection in the Royal Ontario Museum at Toronto. The data amassed to this stage have been analyzed for pollutional significance, and methods of statistical analysis of the data have been developed.

The preserved material has already been subjected to some further study to identify the organisms to species or as far as the present state of systematics permits. This is a continuing task and it is anticipated that the presence of this large collection of material of well known source will stimulate much needed research into systematics.

OUTLINE OF STUDIES

The sampling fell into two sections, an extensive study carried out in 1965 and an intensive study in 1966 and 1967. In the extensive study, seventy-seven samples were taken at different points throughout the study area. Based on the results of this extensive study, fourteen stations were selected, each representing a particular type of environmental situation. These fourteen stations were subjected to intensive study. In this study, six replicate samples were taken at each station, four times in 1966 and three times in 1967. A total of 42 samples were therefore taken at each station in 1966 - 67.

Methods of Study

As the principal purpose of the study was to establish a very reliable baseline of the composition of the benthic invertebrate fauna, the main emphasis was on the quantitative collection of this fauna. During the 1965 season, for the extensive survey a Peterson dredge was used. However, at this period the Ponar dredge was developed, and as this had distinct advantages over the Peterson, the 1966 and 1967 samples were all taken with a Ponar. The Ponar measures 8-1/2 x 9 across the open jaws, and each sample therefore represented 0.53 square foot.

The samples were sieved in situ using a 30 mesh screen to separate the animals and large debris from the mud and fine particles. The sieved samples were immediately preserved in a mixture of formaldehyde and detergent in numbered containers and returned to the laboratory for further sorting and analysis.

At the laboratory the samples were carefully hand sorted by experienced technicians. Small portions of the samples at a time were carefully scrutinized in white enamel trays. The animals were hand picked, sorted into family classifications and the numbers of individuals in each family counted and recorded.

The animals from each sample were then preserved in absolute alcohol in Museum preserving bottles, care being taken to exclude all air, labelled and sent to the Royal Ontario Museum for permanent storage and further study as experts in the various systematic groups became available.

This paper deals only with the distribution of animals as disclosed by the initial count to families. Further work is in progress on the detailed breakdown to species of the stored samples and the results of these studies will be published later.

In addition to the macro-invertebrate fauna collection, measurements were made at the surface and bottom at every station on all collections of dissolved oxygen and temperature. The purpose of this was to check whether lack of dissolved oxygen was a factor in the presence or absence of organisms.

* * *

SUMMARY OF RESULTS OF 1965 SURVEY

Lake St. Louis Section

Seven stations in Lake St. Louis LL1 - 4 are in the part of the lake principally under the influence of Ottawa River water and are situated along the northern side of the lake. LL5 - 7 are in the centre of the lake near the St. Lawrence River channel and are under the influence of the St. Lawrence River water. LL1 to LL5 have a muddy bottom, LL6 and 7, a clay bottom. Depth varies from 15 to 40 feet.

There is a distinct difference in the fauna of Stations LL1 - LL4 compared to LL5 - 7. The former contained significant numbers of nontolerant Ephemeroptera and Trichoptera and good numbers of other groups. There is, however, some evidence of organic enrichment in the high density of Oligochaeta at LL1 and of Pelecypoda in LL4. LL5 - 7 have no nontolerant organisms and small numbers of Chironomidae. The clay bottom may have had some influence on the latter in LL6 and 7, but not in LL5. Ephemeroptera would be expected in a clay bottom. The inference is very strong from this that the Ottawa River in 1965 did not have a significantly pollutional effect on Lake St. Louis, but the St. Lawrence River did.

Ottawa River

Twenty-five stations were sampled in the Ottawa River and four in Lake of Two Mountains. The order of stations in the Ottawa River start at the uppermost point between the two interprovincial bridges in Ottawa, down to Lake of Two Mountains was as follows: OR-18 (uppermost) to OR-25 (at Cumberland Ferry) then OR-17, 16, ... 1 from South Nation River (OR-17 and 16) down to OR-1 (B. de Corbeau, below St. Placide).

At OR-18 between the interprovincial bridges, the bottom contained many wood chips and some mud. There were no nontolerant organisms, and the facultative species were less numerous than would be expected in an unpolluted environment. There was not any evidence of gross enrichment.

The facultative fauna was slightly improved below the Gatineau River, but shows up signs of enrichment below Gatineau (OR-20). At the western end of Kettle Island on a sandy bottom, there was evidence of organic enrichment in the large numbers of Pelecypoda and Gastropoda and moderately large numbers of worms. There were no intolerant organisms and no Chironomidae.

A little farther downstream at the west end of Duck Island and likewise at the eastern end of Duck Island, there were mostly facultative groups, no evidence of gross enrichment and one nontolerant Ephemeroptera.

A further 3-1/2 miles downstream at the eastern end of Way Shoal conditions were similar with rather large numbers of Oligochaeta (515).

Immediately above Cumberland Ferry (and downstream of Lievre River) on the north shore in 10 ft. of water on mud bottom with some fibre, the fauna was very sparse in the one sample taken. This would seem to indicate an isolated area of pollution, but a single sample is not sufficient evidence to be conclusive.

OR-25. Just downstream of Cumberland Ferry in midstream (25 ft. depth) on sandy bottom, the fauna was similar to that upstream, with no nontolerant organisms, large numbers of Pelecypoda and Oligochaeta and fair numbers of other facultative species.

OR-16 & OR-17. At South Nation River, on the north side (10 ft. water and bottom fine sand) and in the channel (22 ft. depth and muddy bottom) there were mostly facultative species, with rather large numbers of Pelecypoda (487) and Oligochaeta on the north side, but also a single nontolerant Ephemeroptera. This sample gives slight indication of some recovery.

OR-15. The next location was in a deep hole (109 ft.) with muddy bottom, opposite Le Faivre. The fauna was sparse except for Oligochaeta, some Pelecypoda, Planaria and Manayunkia. This is a pollution type fauna, but the depth undoubtedly affects this fauna.

OR-13 & OR-14. Taken in L'Orignal Bay respectively at 10 ft. and 90 ft. depths, and both in a muddy bottom. There are no nontolerant organisms and the facultative organisms were only partly representative. This indicates a partially polluted type of fauna.

OR-11 & OR-12. Just upstream of Hawkesbury in 10 ft. and 13 ft. depth with muddy/clay and muddy/sand respectively. The fauna was similar to those upstream with large numbers of Pelecypoda, three Trichoptera in one sample, but otherwise no nontolerant organisms.

OR-10, OR-9, OR-8, OR-7, OR-6, & OR-5. Are all in the artificial lake formed by the Carillon Dam. The depths vary (OR-10 - 18 ft., OR-9 & OR-8 - 15 ft., OR-7 - 10 ft., OR-6 - 55 ft., and OR-5 - 22 ft.). These stations all have a fairly comprehensive facultative fauna and there were some nontolerant organisms in Stations OR-9, OR-7 and OR-6.

In general, the fauna at the Carillon Lake stations shows some evidence of improvement over that of upstream stations.

OR-1 - 4. In the river between Carillon Dam and Lake of Two Mountains. The fauna in these samples shows some evidence of improvement as they proceed downstream, although there is some evidence of organic enrichment, and even at the lowermost station the fauna does not have a full unpolluted make-up.

Lake of Two Mountains

Four stations were sampled in the lake in 10 ft., 15 ft., 28 ft., and 42 ft. of water. The bottom was muddy. The fauna in two stations had only facultative species, but in two there were small numbers of nontolerant organisms. There were rather large numbers of Pelecypoda and Oligochaeta.

The fauna of the lake stations is typical of stations partially recovered from pollution, but does not represent fully unpolluted fauna. The presence of some nontolerant Ephemeroptera and Trichoptera is indicative of recovery to a degree, but the numbers are not typical. The rather large numbers of Pelecypoda and of Oligochaeta in two stations suggest organic enrichment, but the other facultative groups are fairly well distributed.

* * *

DISCUSSION OF RESULTS OF INTENSIVE STUDY

General

The 1965 extensive study had shown that nowhere in the study area was a benthic macroinvertebrate community found which corresponded with a normal completely unpolluted environment. Such a community would contain 10 to 200 individuals of several species of Ephemeroptera and/or Plecoptera, of Trichoptera, probably Coleoptera and, in lentic conditions, Odonata. Group 2 organisms would be represented by several species of all the orders listed in the tables with no species in large numbers (seldom more than 20 individuals/sq. ft.). The Oligochaeta would be represented by several species with only a few individuals of any one species.

The closest approach found to this community were in Station K1 in June 1966 and November 1967, and at LL4 (Lake St. Louis close to the inflow from the Ottawa River) in October and November 1966 and April, July and November 1967, and Lake of Two Mountains in all surveys. The last two are particularly interesting. There has been much speculation in the popular press about pollution of Lake St. Louis. These results show this pollution is due to sources around the shores of the lake and not due to the Ottawa River water which flows into it.

Even these communities were somewhat defective. Although there is no detailed species breakdown in this paper, it was observed that the Ephemeroptera were almost exclusively Hexagenia sp. and there was little species variation among the other Group 3 orders.

One general observation which is pertinent is that up to about ten years ago the emergence of Hexagenia sp. (eel fly) was regarded as a great nuisance along the St. Lawrence valley. This "nuisance" was a good indicators of unpolluted water. Although valley residents may appreciate the lack of large swarms of this insect in early summer, their disappearance unfortunately follows an increase in overall pollution of the St. Lawrence River waters.

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The Ottawa River samples are particularly interesting as an illustration of the gradual downstream recovery of a river from pollution. Undoubtedly, the most serious sources of pollution in the Ottawa River are in the Ottawa region with a secondary source at Hawkesbury and minor additions from the Lievre River and at Thurso and at a number of small towns along the river bank.

OR-25 (Cumberland Ferry) and OR-15 (opposite LeFaivre) illustrate conditions in the 42 miles below Ottawa. Group 3 (sensitive) organisms are almost entirely absent. Group 2 organisms are showing some deficiencies, particularly in Gammaridae and Chironomidae and the numbers of Group 1 (insensitive) organisms indicate some organic enrichment, particularly in November 1967 at OR-25. OR-15 is similar to OR-25, showing there has not been significant recovery 42 miles downstream of Ottawa.

The large numbers of Hirudinea at these stations are typical of communities with organic enrichment leading to high populations of Oligochaeta and Gastropoda on which the leeches are predatory.

OR-13 at L'Orignal Bay shows slight improvement in that there is less evidence of organic enrichment, but the macroinvertebrate community is still deficient due to the effects of pollution. Although the results are not given in this paper, the author has carried out surveys in this area up to ten years previously, and these indicate some deterioration in biological conditions over that period.

OR-9 samples, above Carillon Dam but below Hawkesbury, show more balanced Group 2 organisms content and only moderate evidence of organic enrichment. However, the Group 3 organisms have not returned. There is some biological improvement compared with OR-13, OR-15, and OR-25, but short of recovery. The additional pollution from Hawkesbury does not appear to have caused deterioration although it may have delayed recovery.

OR-1, lower Ottawa 5 miles upstream of Lake of Two Mountains, shows a considerable degree of recovery, particularly in the 1967 samples. There are significant numbers of Ephemeroptera and some Trichoptera and a fairly balanced community of Groups 2 and 1 organisms with no evidence of organic enrichment. This station, although short of completely natural unpolluted environment, represents a good level of recovery from upstream pollution.

The same holds good for the Lake of Two Mountain stations. Group 3 organisms, particularly Ephemeroptera, are well represented. Group 2 organisms show a good balance and there is no evidence of organic enrichment.

It is quite evident from the results of OR-1, L2M2, and LL4, that the pollution from Lake St. Louis is not caused by Ottawa River water.

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