BIOLOGICAL SURVEY
OF THE
HAMILTON BAY AND ADJACENT
LAKE ONTARIO: 1964 - 1965

April, 1966

ONTARIO WATER RESOURCES COMMISSION

Report on the biological survey
of Hamilton Bay and adjacent
Lake Ontario : 1964-1965 /
Johnson, M.G.

ONTARIO WATER RESOURCES COMMISSION

REPORT

on the

BIOLOGICAL SURVEY OF HAMILTON BAY AND ADJACENT LAKE ONTARIO: 1964-1965

by

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Biology Branch

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BIOLOGICAL SURVEY CF HAMILTON BAY AND ADJACENT LAKE ONTARIO: 1964 - 1965

INTRODUCTION

Although many aspects of the limnology of Hamilton Bay have been investigated, the bottom fauna and sediments have not been described. D.H. Matheson has described many physical and chemical characteristics of bay water as well as the plankton populations of Hamilton Bay (1958). Since then additional data of a similar nature are reported each year in the annual reports of the Hamilton Department of Municipal Laboratories. The Municipal Laboratories and Great Lakes Institute of the University of Toronto co-operated in a study of the circulation and water quality in the lake adjacent to Hamilton Bay (Matheson, 1960, 1962; Anderson, Matheson and Whiteman, 1962; Matheson and Anderson, 1965. These numerous reports contain abundant data on currents, temperatures and chemical characteristics of the lake and bay. In addition, the Ontario Water Resources Commission described the industrial wastes discharged to the bay (Phoenix and Vogt, 1964).

This report deals with the results of survey work completed by the Biology Branch of the Commission in 1964 and 1965. Information is provided on the distribution of macroscopic animal life in the sediments of the bay and adjacent lake. Samples of the sediments and water were collected for chemical analyses, in order to relate the distribution of animal types to the chemistry of the supporting environment. Particle-size analyses was carried out on the sediments because it was felt that the texture of sediments would affect animal distribution and indicate subsurface currents.

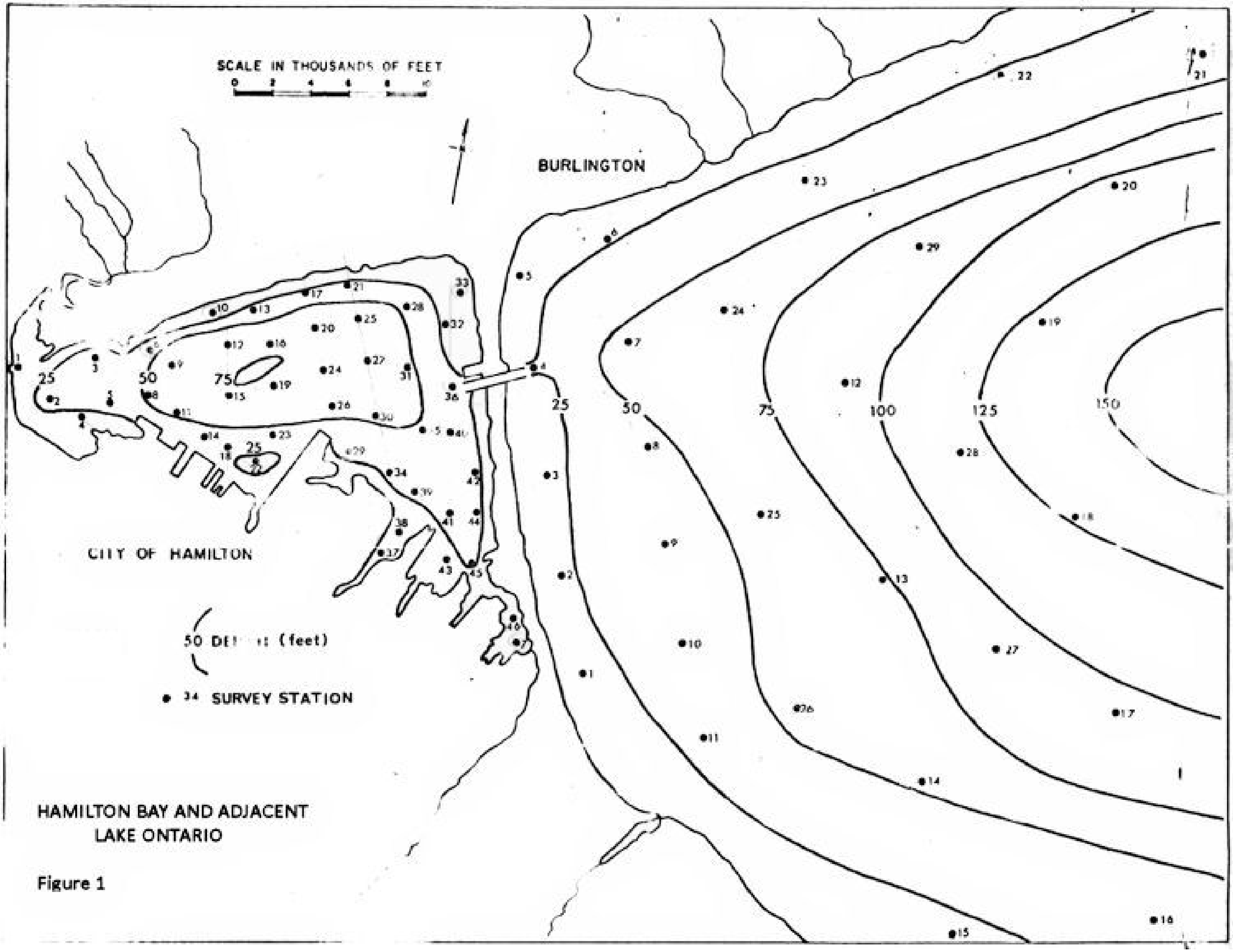
A thorough description of the bottom fauna and the sediments at this time, together with the wealth of water quality data which has been accumulated, will provide an excellent baseline with which future data may be compared.

GENERAL DESCRIPTION OF HAMILTON BAY AND ADJACENT LAKE ONTARIO

The bay is 5 miles long in an east-west direction and 7,000 acres in area. The maximum depth is about 80 feet. The gradient along the northern shore is steep, but extensive shallow areas occur in the western and southeastern parts. Approximately one-quarter of the area of the bay is less than 6 feet deep, one-quarter is between 6 and 30 feet deep and one-half exceeds 30 feet in depth. A limited drainage area, 190 square miles, provides a flow to the bay of about 28,000 million gallons per year in several small streams, many of which are intermittent. Approximately 17,000 million gallons of treated waste water are discharged to the bay. The bay has a volume of about 68,000 million gallons so that the theoretical period of overturn is 1.5 years.

Further information on the bay and its watershed and, of particular interest and importance, the exchange of water between bay and lake, is available in the reports mentioned above.

The morphometry of the area of study is shown in Figure 1. The mills of Stelco and Dofasco are located southeast of centre along the waterfront. The effluent from the new sewage treatment plant which went into operation in July, 1963, is discharged to the Windermere Basin in the extreme southeastern corner of Hamilton Bay.



HAMILTON BAY AND ADJACENT LAKE ONTARIO

Figure 1

Previously untreated wastes were discharged at several points along the waterfront, although most entered the Depew Street and Ottawa Street slips also located just southeast of centre. Therefore, steel-mill wastes and much of the municipal wastes had been added to the bay in the central waterfront area, but during the year preceding the survey municipal wastes were discharged to the Windermere Basin. In addition, the Burlington Skyway sewage treatment plant discharges an effluent of 3.0 mgd to the northeastern corner of the Bay.

Emissions from the bay constitute the major source of contamination in western Lake Ontario. Lesser amounts of waste water are discharged to the lake at Stoney Creek, at several industrial sites along the northern shore and from two additional Burlington treatment plants, the 2.5 mgd Drury Lane plant and 0.8 mgd Elizabeth Gardens plant.

METHODS

The bottom fauna were collected using a box screen (30 meshes per inch) to separate animals from Ekman-dredge samples of the sediment. A core of sediment approximately two inches deep and two inches in diameter was removed from each sample for chemical analyses.

The survey stations are shown in Figure 1. Bedrock and boulders were present at four lake stations, 15, 16, 22 and 23, where it was impossible to take bottom fauna samples by dredge. At these locations qualitative collections of invertebrates were made from rocks, algae and pockets of silt by diving. However, to date only the Ekman-dredge collections have been examined in detail.

Water samples from both epilimnion and hypolimnion were collected during the survey period. Five parameters were selected to describe water quality in the bay and adjacent lake, including total phosphorus, total iron, organic nitrogen, hardness and chemical oxygen demand. These analyses were performed by the Chemistry Branch of the Commission in accordance with standard methods (A.P.H.A., 1960).

Loss on ignition, total nitrogen and acid insoluble materials in bay and lake sediments were determined at the Hamilton Department of Municipal Laboratories in accordance with standard methods (A.P.H.A., 1960). Personnel of the same agency also performed analyses for iron and phosphorus. Iron was determined gravimetrically using the loss-on-ignition residue which was acidified; the iron was oxidized with peroxide and precipitated as the hydroxide. Total phosphorus was determined using the method outlined by Moss *et al.* (1958) following the aqueous suspension of a suitable aliquot of sediment.

Analyses of sediments completed by the Chemistry Branch of the Commission included calcium, chemical oxygen demand (COD) and ether extract (selected samples). Calcium was titrated with EDTA following acid treatment of the sediment and sulfate determined gravimetrically after precipitation as barium sulfate. COD was determined on a dispersion of sediment in distilled water and ether soluble material was extracted directly from a sample of sediment.

Particle-size analyses of sediments were performed during the preparation of this report at the laboratory of the Department of Highways. A thorough study of these data on sediment texture will be made at a later date. For the purpose of the present report the general soil-texture classes have been used.

WATER QUALITY

The data obtained from the collection and analyses of water samples are provided in Table 1. Data on Hamilton Bay are in reasonable agreement with analyses reported by Matheson on the basis of weekly sampling throughout the summer at seven stations, except for iron which was not reported by the Municipal Laboratories for 1964.

Bay water was higher in total hardness than lake water by 45 ppm and in COD by 7 ppm. Bay water contained two and one-half times the concentration of total phosphorus in lake water, seventeen times the concentration of iron and nine times the concentration of organic nitrogen (TKN).

The highest concentrations of iron (1.6-9.0 ppm) were found in the bay at six stations in the vicinity of the steel mills, and the highest concentrations of phosphorus (0.9 1.3 ppm) and nitrogen (6.1 - 7.4 ppm) were found at four stations in the Windermere Basin and Ottawa Street slip, as would be expected. The highest levels in COD (27-32 ppm) occurred at six stations near the waterfront west of the steel mills. In contrast, levels of the five parameters in the lake were fairly uniform over the 29 stations used in this survey.

Considerable information is available on water temperature, coliform concentrations, levels of ammonia, total and nitrate nitrogen, pH, alkalinity, turbidity, BOD and COD, phosphorus fractions and chlorophyll in Hamilton Bay in the Ninth Annual (1964) Report of the Department of Municipal Laboratories. Also data on the chemistry of the treatment plant effluent is provided.

Table 1. Results of chemical analyses performed on samples collected from Hamilton Bay and Lake Ontario during the course of the biological survey carried out in late August and early September, 1964. All results are expressed in ppm.

Analysis	HAMILTON BAY				LAKE ONTARIO			
	Surface		Deep-water		Surface		Deep-water	
	$\bar{x}$ + S$\bar{x}$	(N)	$\bar{x}$ + S$\bar{x}$	(N)	$\bar{x}$ + S$\bar{x}$	(N)	$\bar{x}$ + S$\bar{x}$	(N)
Total phosphorus (PO_4)	0.28 ± 0.04	(25)	0.38 ± 0.04	(44)	0.13 ± 0.04	(26)	0.12 ± 0.04	(22)
Total Iron (Fe_2O_3)	1.58 ± 0.32	(26)	2.30 ± 0.30	(43)	0.13 ± 0.02	(26)	0.11 ± 0.01	(21)
TKN (N)	4.31 ± 0.39	(25)	3.25 ± 0.23	(42)	0.47 ± 0.04	(26)	0.41 ± 0.03	(21
Hardness (as $CaCO_3$)	183 ± 2	(24)	178 ± 2	(38)	133 ± 5	(26)	139 ± 1	(22)
COD	20.7 ± 1.9	(22)	18.8 ± 1.5	(40)	13.7 ± 1.2	(26)	11.2 ±1.2	(22)

N = number of analyses;
S$\bar{x}$ = standard error of mean, $\bar{x}$

CHARACTERISTICS OF THE SEDIMENTS

An examination of several characteristics of the sediments of Hamilton Bay and adjacent Lake Ontario was made to determine the distribution of nutrient and possibly toxic materials which might influence the nature of the bottom fauna community. Such materials are deposited by physical, chemical or biogenic precipitation. Currents, depth of sedimentation and character of the deep water affect the resuspension or solution of bottom materials.

Physical characteristics

Silt and clay deposits comprised the bottom in the main basin of the bay and in the very shallow Windermere Basin However, in an area adjacent to the harbour entrance the sediments were markedly different, being composed of mainly fine sands with lesser amounts of silt, clay and coarse sand. This finding indicated that currents of significant velocity occur at depths up to about 50 feet, if not continuously then at least periodically, over that part of the bay near the entrance. Matheson and Anderson (1965) found that an inflow of deep water at the harbour entrance was a usual occurrence as the surface water of the bay moved into the lake.

Mainly coarse and fine sands comprised the bottom sediments in Lake Ontario to a water depth of about 50 feet; at deeper points only silts and clays were found. Obviously the fine particles are sorted towards deeper levels in Lake Ontario than in the bay.

Iron

Apparently 70 tons of iron are discharged to the bay daily. Therefore, it is not surprising that the level of iron in bay sediments is extremely high. Over approximately 500 acres, iron made up one-quarter or more of the weight of dried samples. One sample contained 74% Fe_2O_3. Iron comprised more than 15% of sediments in approximately one-half of the area of the bay. Figure 2 illustrates the deposition of iron in large quantities near the miles and over much of the deep basin of the bay and western waterfront.

Little iron is maintained in the shallower, coarser sediments of the lake except at the harbour entrance. The lake sediments deeper than 50 feet contained between 5 and 10% Fe_2O_3 except at Stations 13 and 25. The plume of high iron concentration which appeared to spread directly eastward from the harbour entrance is probably a reality because of the high levels of 6.9, 8.0, 7.6, 7.2 and 9.0% Fe_2O_3 found at Stations 7, 12, 24, 28 and 29. These are similar to levels within the bay near the entrance. However, the designation of an area of high iron content in the lake south of the main plume, which is shown in Figure 2 directed back towards the harbour, may have little significance if any.

Loss on ignition

The area of highest organic matter content occurred over the *deep* basin and the southeastern part of the bay including the shallow Windermere Basin (Figure 3). Particularly great concentrations, 15.1 to 24.2% loss on ignition, were found at Stations 37, 38, 41 and 44, in the Ottawa Street slip and in adjacent sediments in the bay. Areas of sediment having less than average organic content occurred in the northern and western extremities of the bay, in the shallower sediments west of the steel mills and near the harbour entrance.

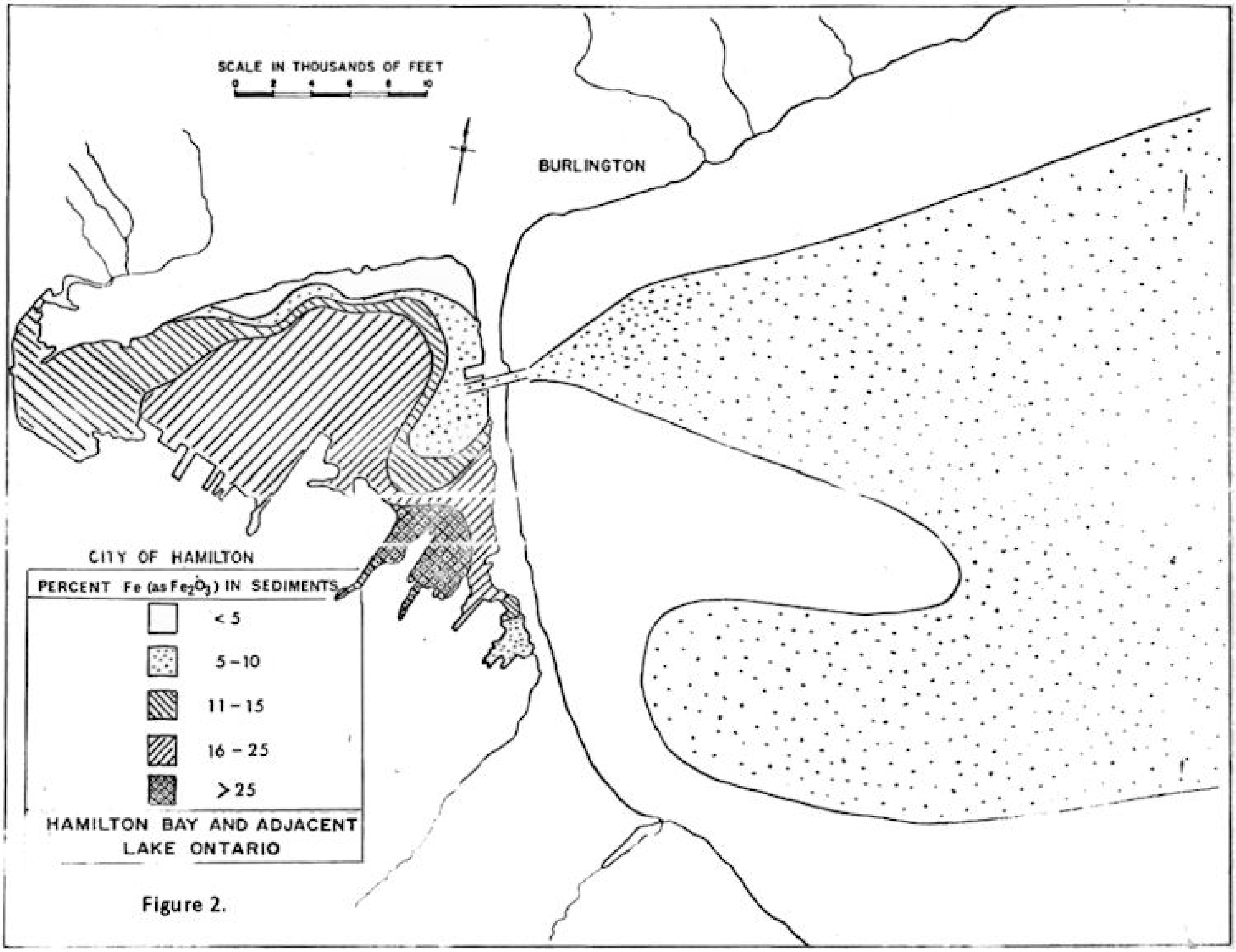

SCALE IN THOUSANDS OF FEET
0 2 4 6 8 10
BURLINGTON
CITY OF HAMILTON
PERCENT Fe (as Fe_2O_3) IN SEDIMENTS
< 5
5 – 10
11 – 15
16 – 25
> 25
HAMILTON BAY AND ADJACENT
LAKE ONTARIO

Figure 2.

A plume of sediments rich in organic matter was evident in Lake Ontario. Sediments mainly of fine sands in water shallower than 50 feet had much less organic matter, as would be expected.

Total phosphorus and nitrogen

The phosphorus content of the sediments was highest in and adjacent to the Ottawa Street slip and in the deeper part of the main basin (Figure 4). The pattern of distribution of phosphorus was similar to that of organic matter. The phosphorus content was lowest along the northern shore, in shallows west of the steel mills and near the harbour entrance. Levels in lake sediments were much less than in bay sediments and formed no apparent concentrated plume directly east of the harbour entrance.

Matheson estimated that 90% of the phosphorus loading to the bay, about 10 tons PO_4 daily, is removed in the sediments of the bay. On the basis of the average concentration of phosphorus in these sediments, the deposition of one-quarter inch of sediment annually would account for this degree of removal of phosphorus, all of which appears to be a realistic appraisal.

The organic nitrogen content of the sediments was closely related to loss on ignition and the distribution, not illustrated here, was very similar to the latter. A plume of higher-than-average organic nitrogen levels in lake sediments occurred eastward from the harbour entrance, and sorting into the deeper, protected sediments was evident. The greatest concentration of organic nitrogen, 0.28% N, occurred in the sample from Station 19, which is directly east of the harbour entrance. Sy comparison, the levels at Stations 17 and 18 south of 19 were less, 0.23 and 0.19% N respectively.

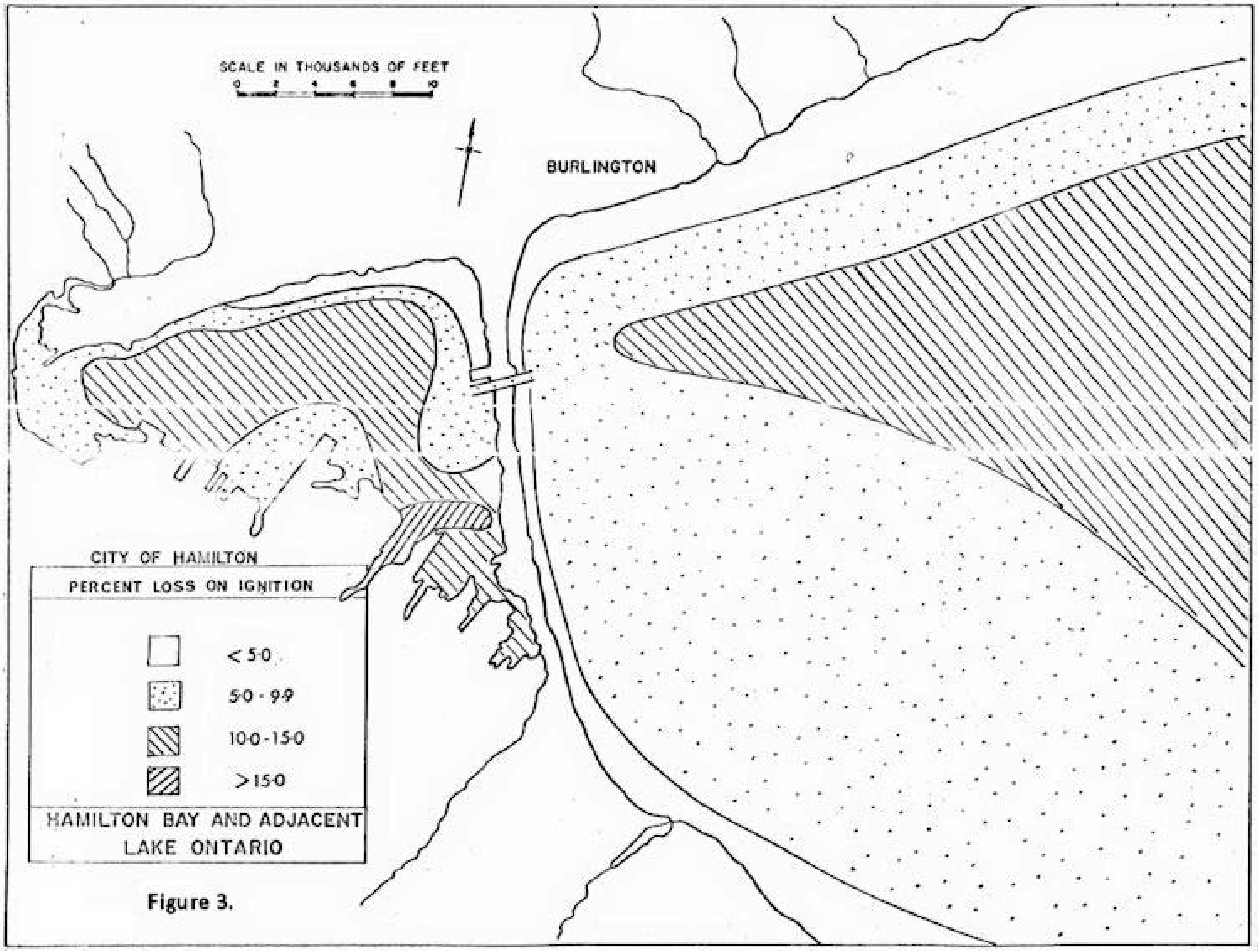

SCALE IN THOUSANDS OF FEET
0 2 4 6 8 10
BURLINGTON
CITY OF HAMILTON
PERCENT LOSS ON IGNITION
< 5·0
5·0 - 9·9
10·0 - 15·0
> 15·0
HAMILTON BAY AND ADJACENT
LAKE ONTARIO

Figure 3.

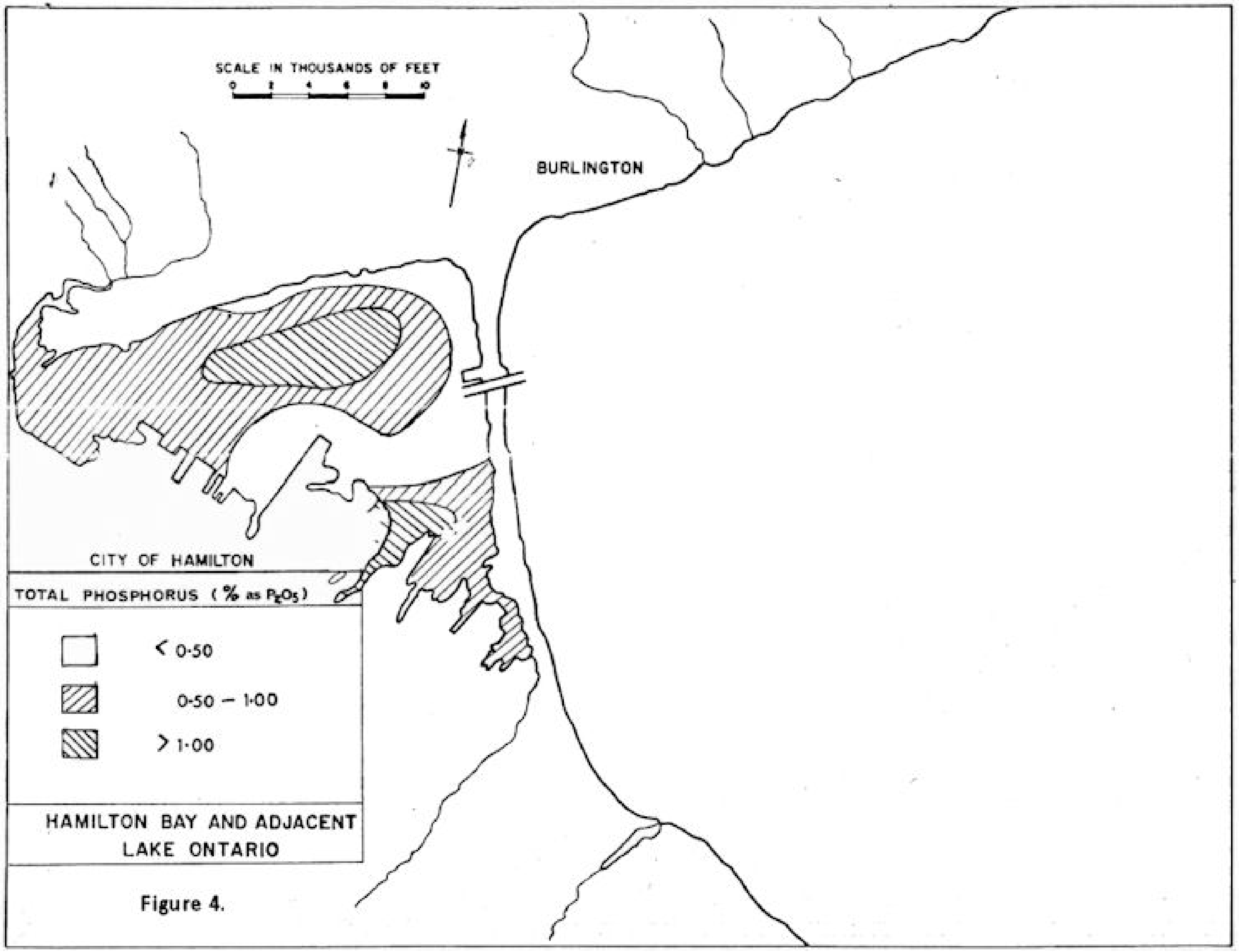

SCALE IN THOUSANDS OF FEET
0 2 4 6 8 10
BURLINGTON
CITY OF HAMILTON
TOTAL PHOSPHORUS (% as P_2O_5)
< 0·50
0·50 – 1·00
> 1·00
HAMILTON BAY AND ADJACENT
LAKE ONTARIO

Figure 4.

Other Chemical Characteristics

Calcium concentrations were 3.4% and 1.6% in bay and lake sediments respectively. Calcium levels were greater than average in sediments from the eastern half of the bay except in the two samples from the Ottawa Street slip. The sediments from several of the more shallow stations in the lake had greater calcium content than deeper sediments.

Sulfate concentrations were uniformly low, about 0.3%, in lake sediments. Bay sediments continued approximately 1.1% sulfate, with the greatest concentrations being found in sediments of the main basin at depths below 50 feet and in deep water east of the steel mills.

COD in both bay and lake sediments was closely related to loss on ignition and no further interpretation of COD levels appears to be necessary.

Limited data on concentrations of oil and grease (ether extract) indicated that the bay sediments contained about ten times the amount of oil and grease in lake sediments, (0.50% in bay sediments, 0.05% in lake sediments). Some bay samples had ether extracts approaching 1.0% and sediment samples from these stations appeared quite oily at the time of collection.

THE BOTTOM FAUNA

The composition and size of the standing crop of bottom animals will be described and related to some characteristics of the sediments and overlying water.

Collections in Hamilton Bay consisted mainly of sludge-worms. Midges were present along the northern shore, the western end, Windermere Basin and adjacent to the harbour entrance. An area of several hundred acres near the steel mills was devoid of even sludgeworms (Figures 5 and 6).

The numbers of sludgeworms, where they were present, varied between 7 and 2260 per square foot. Generally, they were least abundant in the northeastern part of the bay in shallow, sandy sediments and near the steel mills. Greatest numbers occurred throughout the main basin and western end, with very great densities in the vicinity of the harbour entrance (Figure 5).

Sludgeworms were absent or present in very low numbers in several samples of coarser-grained sediments in shallower waters in Lake Ontario. However, in the finer-grained sediments deeper than about 50 feet sludgeworms were common in consistently moderate numbers. No more than 100 worms per square foot were found in any sample from the lake and only three held less than 10.

The bottom fauna of the lake was varied. Fingernail clams, snails, isopods and amphipods, midges and worms occurred in the samples. Snails and isopods were the least abundant, while the amphipod, *Ponteporeia affinis*, was numerous in many samples. The diversity in the lake bottom fauna is evident in Figure 6, in contrast to that of Hamilton Bay.

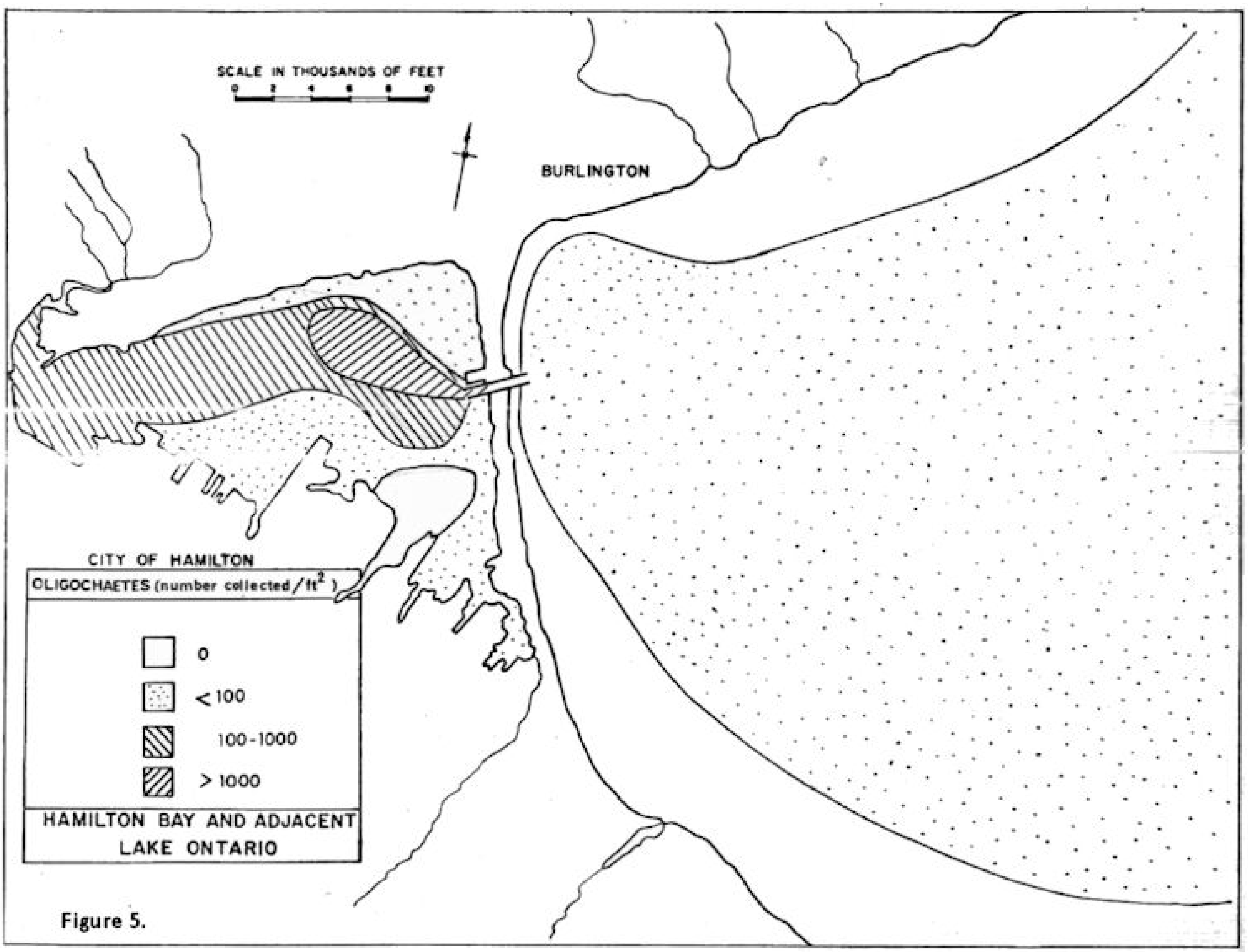

SCALE IN THOUSANDS OF FEET
0 2 4 6 8 10
BURLINGTON
CITY OF HAMILTON
OLIGOCHAETES (number collected / ft²)
0
< 100
100-1000
> 1000
HAMILTON BAY AND ADJACENT
LAKE ONTARIO

Figure 5.

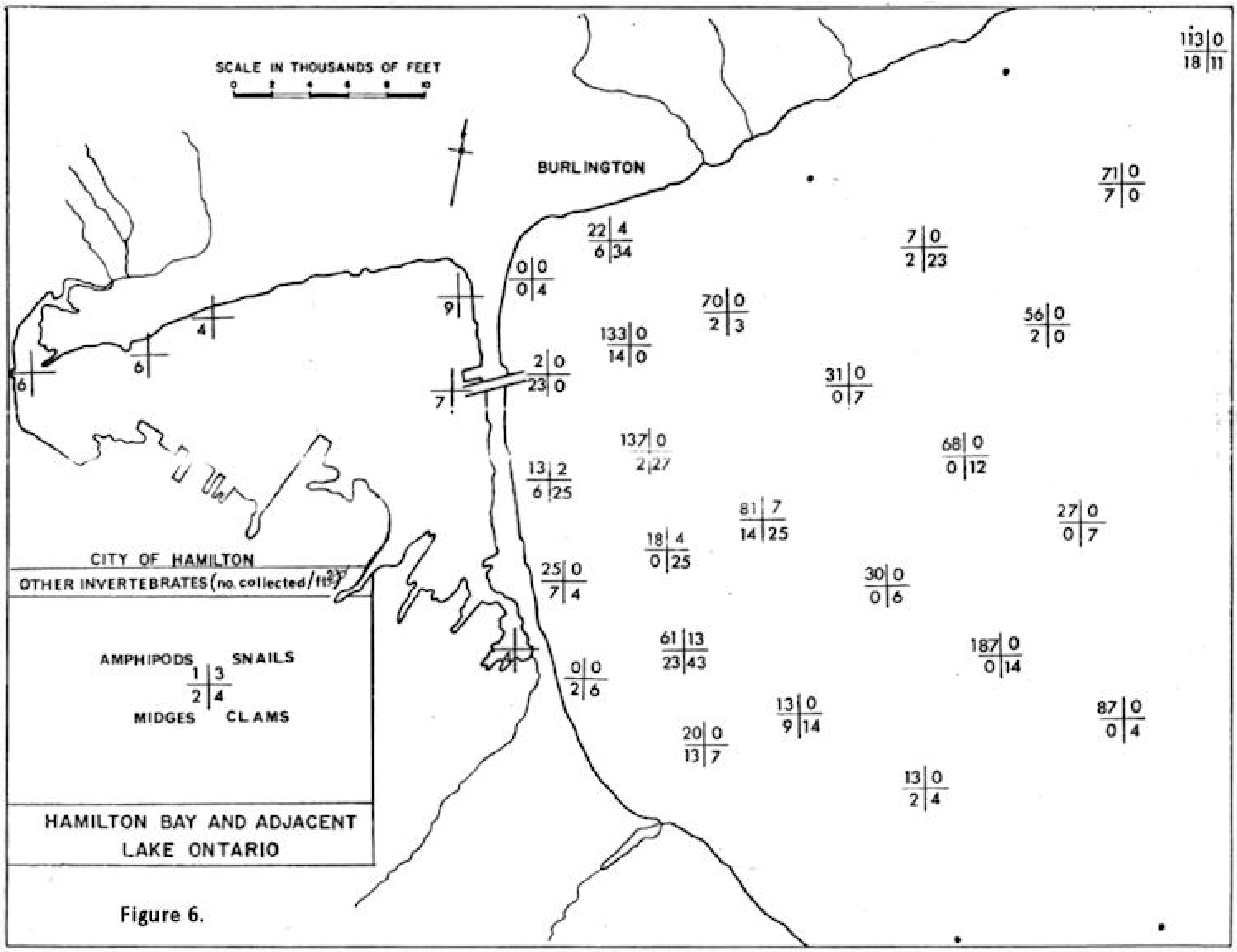

SCALE IN THOUSANDS OF FEET
0 2 4 6 8 10
BURLINGTON
CITY OF HAMILTON
OTHER INVERTEBRATES (no. collected/ft²)
AMPHIPODS
SNAILS
MIDGES
CLAMS
1 | 3
2 | 4
HAMILTON BAY AND ADJACENT LAKE ONTARIO
9
4
6
6
7
113 | 0 / 18 | 11
71 | 0 / 7 | 0
22 | 4 / 6 | 34
7 | 0 / 2 | 23
0 | 0 / 0 | 4
70 | 0 / 2 | 3
56 | 0 / 2 | 0
133 | 0 / 14 | 0
2 | 0 / 23 | 0
31 | 0 / 0 | 7
137 | 0 / 2 | 27
68 | 0 / 0 | 12
13 | 2 / 6 | 25
81 | 7 / 14 | 25
27 | 0 / 0 | 7
18 | 4 / 0 | 25
25 | 0 / 7 | 4
30 | 0 / 0 | 6
61 | 13 / 23 | 43
187 | 0 / 0 | 14
0 | 0 / 2 | 6
13 | 0 / 9 | 14
87 | 0 / 0 | 4
20 | 0 / 13 | 7
13 | 0 / 2 | 4

Figure 6.

The species which were found in 1964 in the 71 collections are listed in Table 2 and those found in the bay are designated. Thirteen species occurred in the bay compared with about 30 in the Lake Ontario samples. Most of the species in the bay were restricted in both range and abundance. Only two species, *Limnodrilus hoffmeisteri* and *Tubifex tubifex*, were abundant. In the absence of other species they form a community characteristic of heavily polluted waters.

The area of absence of sludgeworms in the bay coincided very closely with the area where the iron content of the sediments exceeded 25%. Because the sources of iron and organic matter in municipal wastes were both in this area until recently, the level of organic matter was very high and probably would support large populations of sludgeworms except for the presence of iron which may exert a direct toxic effect or interfere because of excessive turbidity and sedimentation. Probably the high concentrations of iron in the overlying water and sediments is directly toxic.

The large numbers of worms in the main basin may be correlated with the corresponding high levels of organic matter and nutrients which are sorted to these deeper sediments. Past records (Matheson, 1963) indicate that oxygen is not entirely depleted in the deep waters of the main basin. Probably the influx of lake water is an important factor in maintaining a supply of oxygen in this area. The level of iron was rather great in these sediments, 16 to 25%, but apparently was not inhibitory to the two common species of sludgeworm at least.

The very large population of worms near the harbour entrance occurred in an area of sediments which were no higher in organic matter, nitrogen and phosphorus content than those in the main basin. However, the texture of the sediments indicated the presence of currents, obviously representing the periodic influx of cold lake water

Table 2. Species determined in 71 collections of bottom fauna from Hamilton Bay and adjacent Lake Ontario made in August and September, 1964.

Group	Genus	Species
Fingernail clams	*Pisidium*	*P. compressum*
		P. casertanum
		P. variable
		P. supinum
		P. nitidum
		P. lilljeborgi
		P. henslowanum
		P. conventus
		P. idahoense
	Sphaerium	*S. transversum*
		S. corneum
		S. nitidum
Snails	*Valvata*	*V. sincerea*
		V. tricarinata
Amphipods	*Ponteporeia*	*P. affinis*
Isopods	*Asellus*	*A. militaris*
Midges	*Chironomus*	*C. decorus* *
	Cryptochironomus	*C. digitatus*
	Glyptotendipes	*G. polytomus* *
	Calopsectra	sp.
	Procladius	sp.*
	Tanypus	*T. stellatus* *
	Spaniatoma	sp.
Oligochaetes	*Limnodrilus*	*L. hoffmeisteri* *
		L. cervix *
		L. udekemianus *
		L. clapararedeanus *
		L. profundicola *
	Tubifex	*T. tubifex* *
	Peloscolex	*P. ferox* *
		P. multisetosus *
	Euilyodrilus	*E. moldaviensis* *
	Stylodrilus	*S. heringianus*

* found in Hamilton Bay

mentioned previously. To determine whether the influx of lake water and greater numbers of worms in the path of these currents were related, six collections were made in 1965 on a line across the harbour entrance (line B in Figure 7). The numbers collected per square foot appeared to substantiate the hypothesis. In addition, six samples were collected from the main basin at a centrally located site (point A in Figure 7) to determine populations in 1965 and to assess the variability in worm numbers. The mean number was 285 worms per square foot and its standard error was 115 (40%). The mean number of worms in the same general location in 1964 was 366 per square foot. The number of worms near the harbour entrance was very high, in thousands per square foot at Station 36, in both years. Therefore, this area characterized by large populations was distinct in the two years and the high numbers of worms probably resulted from a combination of improved water quality and movement in combination with the generally high concentration of organic materials typical of bay sediments. The intrusion of midges into the bay near the entrance and the presence of one fingernail clam there in 1965 also indicated the influence of lake water.

Additional collections in 1965 in the vicinity of Station 4 off the entrance to the bay point D in Figure 7) showed that numbers of worms were again between 10 and 100 in the lake sediments. Between 17 and 95 worms per square foot occurred in six collections. The mean and its standard error were 74 and 33 worms respectively. The Windermere Basin was examined in 1965 (point C in Figure 7) and fewer worms were recovered than in 1964; only seven worms were taken in six collections. No explanation for this difference is apparent at this time.

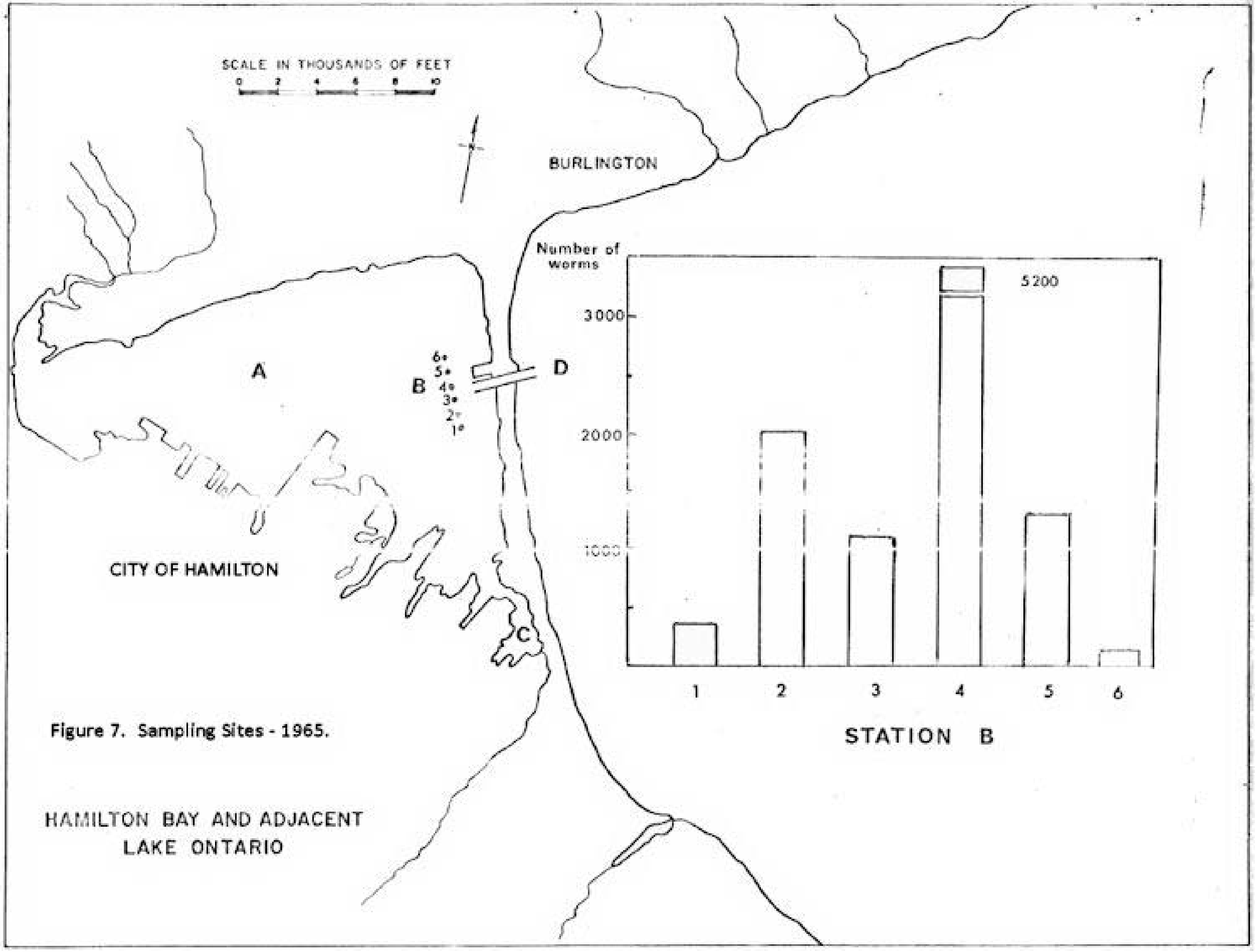


Figure 7. Sampling Sites - 1965.

The distribution of the major groups in the bottom fauna of Lake Ontario (Figure 6) did not indicate differences in the quality of water or underlying sediments except differences due to water depth. Apparently the largest standing crops occurred at intermediate depths (Figure 6). Smaller numbers of animals were taken at inshore stations and from the six deepest samples. The absence of fingernail clams in 1964 at Stations 4 and 7 in line with the harbour entrance was noted with some suspicion. However, clams were found in the six samples taken in 1965.

The differences in chemical characteristics of the bottom sediments between stations in the northern and southern parts of the lake, for example in iron and nitrogen content, probably represented real differences in deposition. While these chemical data indicated that the circulation of bay water may tend mainly toward the northern shore, the most obvious relationship was between sediment chemistry and depth (Figure 8). Similarly, most differences in bottom communities appeared to be due to water depth or changes in sediment characteristics related to depth (Figure 8). However, the sampling program was minimal for both chemical and biological materials.

Although an intensified sampling program might detect some differences in bottom fauna communities other than those due to water depth, the data of this study support the findings of Matheson and Anderson (1965) that the motion of effluents from the bay is not at all regular. The differences in the chemistry of lake sediments formed no clear-cut, striking patterns in relation to any effluent pattern which might exist, while the distribution of bottom organisms was even less indicative of concentration of bay water toward any specific part of the western end of Lake Ontario adjacent to Hamilton Bay.

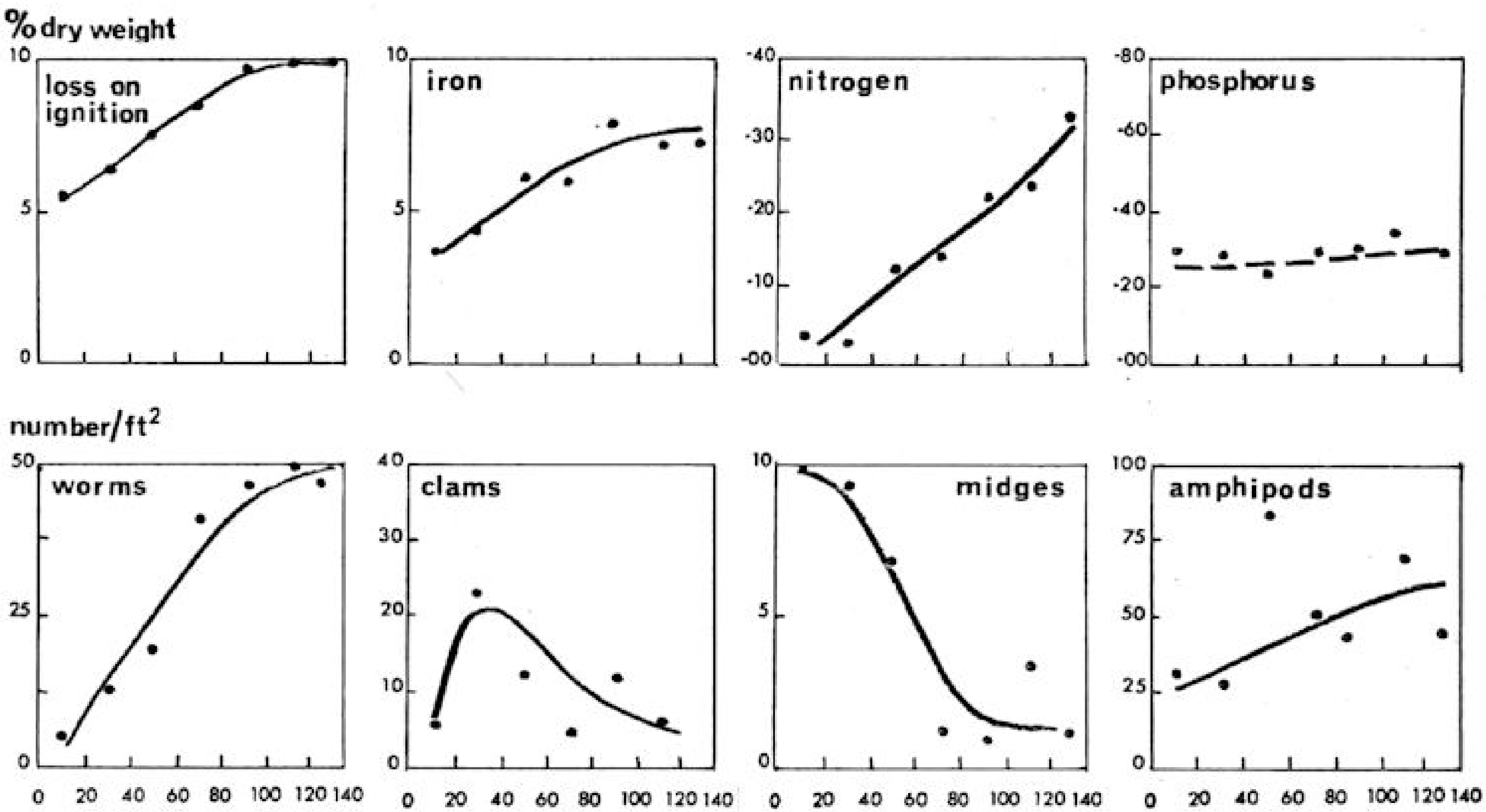


Figure 8. Mean concentration of four chemical parameters of lake sediments and mean numbers of the four common invertebrate groups at 20-foot depth intervals based on 1964 collections.

The bay is heavily polluted as shown by water analyses, sediment analyses and biological collections. While this fact is not new, the data nonetheless will augment the already large collection of data on Hamilton Bay and aid in the future interpretation of water quality as abatement procedures are introduced and intensified.

ACKNOWLEDGEMENTS

D. H. Matheson and his staff provided encouragement and material assistance with the survey, including the arrangements for several trips on the lake on the tug, Plainsville, courtesy of the Royal Canadian Navy, H.M.C.S. Star.

H. B. Herrington identified the fingernail clams collected in lake sediments. R. O. Brinkhurst of the University of Toronto examined some of the collections of worms and checked identifications of other specimens. Similarly, J. K. Neel of the University of Louisville provided help with the midge larvae. G. J. Hopkins, D. M. Pugh and D. S. Osmond took part in the field program. F. R. Phoenix, Industrial Wastes Division, O.W.R.C., provided considerable information throughout the study.

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APPENDIX

Table 1. Results on chemical analysis of sediments collected in Hamilton Bay and adjacent Lake Ontario in August and September, 1964. Station locations are shown in Figure 1.

Station	Depth (Feet)	Loss on ignition	Acid insol. material	% Fe_2O_3	Total Org. N	Total P_2O_5	C.O.D.	% Calcium	Sulfate	Ether extract
HB 1	15	7.4	-	10.0	0.25	0.50	9.7	2.1	0.7	-
2	29	8.8	-	13.1	0.29	0.75	9.5	1.9	1.1	-
3	42	10.4	-	13.4	0.34	1.00	18.4	1.2	1.2	-
4	26	9.5	-	12.1	0.27	0.75	15.0	1.3	1.0	-
5	39	10.3	-	12.1	0.32	0.85	10.0	0.5	1.3	
6	48	11.5	-	14.5	0.42	0.90	12.3	1.2	1.8	-
7	7	6.9	69.0	6.6	0.23	0.65	8.9	1.7	0.9	-
8	50	43.4	-	15.3	0.52	0.95	15.0	0.9	1.9	-
9	58	11.6	-	14.2	0.37	0.95	11.5	0.7	2.1	-
10	20	7.1	-	10.6	0.24	0.80	8.1	1.4	0.8	0.23
11	55	12.6	-	12.9	0.31	0.70	11.3	1.0	1.5	0.49
12	66	14.2	50.8	18.0	0.47	1.05	15.0	4.2	2.0	-
13	37	2.9	80.5	4.0	0.09	0.30	4.1	3.6	0.4	-
14	50	23.0	38.9	20.1	0.54	3.15	5.6	0.8	1.8	-
15	53	14.1	51.2	15.6	0.32	0.80	11.9	0.8	1.8	-
16	70	13.9	52.0	16.3	0.38	0.95	13.4	2.4	1.4	-
17	50	14.6	51.8	18.4	0.41	1.00	15.0	4.3	1.3	-
18	45	9.5	48.0	17.9	0.15	0.45	11.0	7.6	1.1	-
19	75	8.0	57.2	10.5	0.22	0.50	8.0	4.8	1.1	-
20	65	14.6	48.4	18.3	0.46	1.05	15.6	4.6	1.3	-
21	25	1.8	93.7	0.9	0.02	0.08	3.5	1.0	0.1	-
22	20	11.4	54.0	15.0	0.21	0.50	15.0	0.4	0.9	-
23	49	6.6	67.2	6.9	0.18	0.30	9.7	0.5	0.3	-
24	70	16.7	46.3	18.0	0.48	1.05	17.7	6.0	2.1	-
25	55	11.4	52.7	17.7	0.36	1.00	12.3	3.7	1.7	-
26	55	8.8	59.5	10.4	0.12	0.40	4.4	4.3	1.1	-
27	60	13.0	54.3	18.0	0.35	0.95	12.3	4.2	0.3	0.68
28	50	11.6	60.9	12.6	0.31	0.70	9.1	4.6	1.9	-
29	30	9.6	61.6	10.0	0.15	0.45	7.9	0.6	3.4	0.89
30	55	14.9	50.3	17.4	0.36	0.80	13.0	6.2	1.4	-
31	50	14.3	50.8	16.9	0.34	0.90	11.9	5.6	0.1	-
32	25	8.0	70.4	8.2	0.16	0.65	5.6	5.3	0.2	-
33	8	4.1	78.2	4.3	0.08	0.30	3.1	4.6	0.5	-
34	40	10.2	49.6	14.2	0.31	0.70	12.0	6.3	2.3	-

Table 1. continued

Station	Depth (Feet)	Loss on ignition	Acid insol. material	% Fe_2O_3	Total Org. N	Total P_2O_5	C.O.D.	% Calcium	Sulfate	Ether extract
35	50.0	6.9	46.4	9.1	0.26	0.35	9.4	11.4	0.6	-
36	41.0	2.2	74.7	3.2	0.04	0.45	2.2	6.2	0.3	-
37	16.0	15.6	11.6	73.5	0.27	1.05	34.0	0.3	0.5	-
38	21.0	21.6	12.1	63.9	0.72	1.35	34.0	0.2	0.7	-
39	25.0	7.5	62.2	9.5	0.15	0.35	6.0	6.4	0.3	0.22
40	40.0	4.6	70.4	6.5	0.08	0.35	3.8	5.4	0.8	-
41	35.0	15.9	36.9	29.4	0.45	1.35	20.0	3.8	2.1	-
42	40.0	8.3	56.6	16.9	0.23	0.65	11.0	5.5	0.5	-
43	6.0	10.0	41.9	29.5	0.27	0.55	14.0	5.0	2.0	-
44	15.0	24.2	49.9	10.0	1.00	0.55	34.0	2.9	1.7	-
45	26.0	8.2	56.7	12.3	0.25	0.75	8.5	4.8	0.8	0.77
46	10.0	12.9	54.9	8.4	0.49	0.35	14.0	6.4	0.7	0.28
LO 1	16.5	5.5	-	3.9	0.01	0.48	0.6	4.2	0.3	-
2	24.0	6.6	-	3.8	0.01	0.20	0.7	4.3	0.2	0.05
3	21.0	6.4	-	4.0	0.01	0.24	0.6	3.4	0.1	-
4	13.5	8.2	-	3.4	0.06	0.24	3.9	2.4	0.3	-
5	4.5	6.0	-	4.0	0.01	0.20	0.5	2.4	0.1	-
6	25.5	4.9	-	2.9	0.01	0.24	0.6	0.2	0.1	-
7	42.0	10.6	-	6.9	0.15	0.30	5.6	1.5	0.3	-
8	46.0	5.2	-	4.1	0.04	0.26	0.9	2.2	0.1	0.02
9	39.0	5.5	-	4.0	0.03	0.38	0.8	1.2	0.1	-
10	39.0	7.5	-	6.1	0.06	0.30	1.9	0.2	0.3	-
11	37.5	7.8	-	5.3	0.05	0.28	1.6	2.4	0.3	0.03
12	96.0	10.7	-	8.0	0.20	0.30	6.3	0.7	0.5	-
13	72.0	6.8	-	4.0	0.04	0.25	1.6	1.2	0.2	-
14	52.0	8.7	-	7.0	0.18	-	4.5	0.5	0.6	-
17	96.0	8.4	-	7.0	0.23	0.36	6.7	0.2	0.4	-
18	135.0	10.3	-	7.3	0.19	0.30	6.9	1.8	0.8	-
19	138.0	10.4	-	7.6	0.28	0.34	8.4	1.1	0.6	-
20	120.0	10.4	-	7.2	0.22	0.38	7.4	0.5	0.2	-
21	15.9	3.1	-	4.2	0.07	0.38	2.4	2.2	0.5	-
24	72.0	10.0	-	7.6	0.23	0.38	7.2	0.6	0.6	-
25	48.0	5.2	-	3.8	0.03	0.30	0.9	1.0	0.2	-
26	51.0	9.0	-	8.2	0.20	0.33	5.9	0.7	0.6	-
27	48.0	6.4	-	6.5	0.15	0.31	5.4	1.4	0.5	-
28	102.0	10.1	-	7.2	0.23	-	8.9	1.4	0.4	0.15
29	96.0	10.5	-	9.0	0.23	0.34	5.2	-	-	-