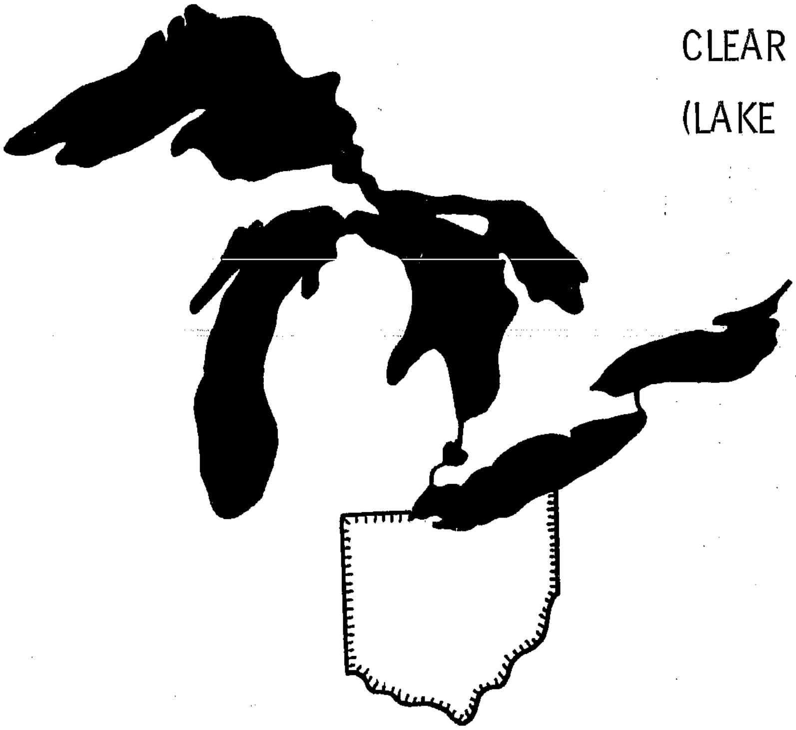

CLEAR TECHNICAL REPORT NO. 232

(LAKE ERIE TAT CONTRIBUTION NO. 7)

LAKE ERIE INTENSIVE STUDY: MICROBIOLOGY IN MAIN LAKE AND NEARSHORE WATERS

Prepared by

C. Lawrence Cooper
and
Cheryl L. Kimerline

Prepared for

U.S. Environmental Protection Agency
Great Lakes National Program Office
Region V - Chicago, Illinois
Grant No. R005516001

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

DECEMBER 1981

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INTRODUCTION

The microbiological portion of the 1978-1979 International Surveillance Plan of Lake Erie involved the collection of aerobic heterotrophic bacteria, total coliform bacteria, fecal coliform bacteria, fecal streptococci and *Pseudomonas aeruginosa*. Bacterial data was collected on four cruises each year during the intensive nearshore portion of the surveillance study. Samples were taken at each station along the shoreline of the western, central and eastern basins.

The intensive nearshore survey was conducted by several governmental agencies and educational institutions. Three groups collected nearshore bacterial data along the U.S. shoreline. Personnel from The Ohio State University (CLEAR) collected samples and analyzed data from the western basin (Diamond, Fort and Bartish 1980). Heidelberg College personnel collected samples and analyzed data from the central basin (Stanford 1981). Personnel from the State University College of New York at Buffalo collected samples in the eastern basin. On the north shore, the Ontario Ministry of the Environment was responsible for collecting nearshore samples. Ministry personnel undertook a similar project in 1975 in the Canadian portion of the Detroit River (Kinkead and Hamdy 1976). The USEPA Great Lakes National Program Office was responsible for collecting samples for total aerobic heterotroph determinations in the main lake portion of the study. Other bacteria surveillance efforts involved collecting samples at water intakes, tributaries and beaches (Table 1).

This preliminary report summarizes the nearshore intensive survey by reach (Figure 1). Figures 2-22 display monthly mean values (STORET system) over the two-year interval for total heterotrophic bacteria, fecal coliforms, fecal streptococci, FC/FS ratios and total coliform bacteria along the following reaches of the Lake Erie nearshore zone:

1. Point Mouille (Detroit) → Marblehead
2. Sandusky → Cleveland
3. Cleveland → Erie
4. Erie → Buffalo
5. Niagara R. → Port Maitland
6. Port Maitland → Long Point
7. Long Point → Rondeau
8. Rondeau → Pelee Pt.
9. Pelee Pt. → Windsor

Samples were collected to determine the presence of total aerobic heterotrophs (TAH) in main lake water and in the waters of the nearshore zone of the United States. The determination of TAH has been useful in monitoring water quality and for studying its relationship with nutrient parameters. TAH has been used as a general indicator of organic and inorganic pollution. This use has been extended to include total aerobic heterotrophic bacteria in the determination of lake eutrophication status (Bowden *in* Stanford 1981). Total aerobic heterotroph data can be used to determine the trophic status of a lake by classifying stations according to the following criteria:

	inshore (organisms/ml)	offshore (organisms/ml)
eutrophic	≥ 2000	≥ 200
mesotrophic	$120 < M < 2000$	$20 < M < 200$
oligotrophic	≤ 120	≤ 20

With the exception of main lake waters, fecal coliform and fecal streptococci determinations were preformed in most portions of the Lake Erie Surveillance study. Total coliform and fecal coliform determinations were conducted in the Detroit and Niagara Rivers. Total coliform and fecal streptococci determinations were reported for the nearshore zone in Canadian waters of the lake. Fecal coliforms were studied to detect the presence of fecal pollution which could present potential health hazards if containing Salmonella, Shigella or other water-borne pathogens. Fecal coliforms are the standard indicators for domestic pollution. Fecal streptococcus data was used along with the corresponding fecal coliform data to determine the origin of fecal pollution using the fecal coliform/fecal streptococcus ratio (FC/FS) (Geldreich and Kenner 1969). By applying the ratio, it is possible to assess if fecal contamination is of human or livestock origin. In general, if the ratio is ≤ 0.7, the bacteria are assumed to be of animal (i.e., non-human) origin. If the FC/FS ratio is ≥ 4.0, the bacteria are assumed to be from domestic sewage effluent. Sources of bacterial contamination producing FC/FS ratios between 0.7 and 4.0 cannot be adequately determined.

Hoadey (1968) stated that Pseudomonas aeruginosa is a pathogen of man and animals causing eye, ear, nose and throat infections, skin eruptions and digestive disorders. It has also been noted as a spoilage organism and a slime-former. Samples were collected in 1978 during the U.S. portion of the intensive nearshore effort to identify sources of P. aeruginosa in lake water. In this instance, P. aeruginosa served as an indicator of sewage.

RESULTS AND DISCUSSION

Total Aerobic Heterotrophs (TAH)

Point Mouille (Detroit, Michigan) to Marblehead, Ohio Reach. The levels of total aerobic heterotrophs (TAH) decreased from spring to summer in 1978. Mean monthly values were highest (1.75×10^5/ml) in April and lowest ($\sim 5.0 \times 10^3$/ml) in October (Figure 2). In 1979, maximum values occurred in March, minimum values in September. In both years, an increase following the summer low occurred in the fall. Monthly mean values of TAH bacteria in the nearshore waters of this reach of the lake were well in excess of the inshore eutrophic status criterion of 2000 organisms/ml.

Sandusky to Cleveland, Ohio Reach. The TAH bacteria levels in 1978 were highest in the spring, reaching maximum values (7.9×10^5/ml) in May and subsequently dropping sharply to a minimum monthly mean in August (1.0×10^4/ml). Following the summer low, TAH levels increased in the fall. Monthly

September mean values exceeded October values. In 1979, maximum TAH numbers occurred in April (1.1×10^5/ml). TAH monthly means were relatively low and constant during the remainder of the year. The minimum monthly mean occurred in October (1.0×10^4/ml) (Figure 3). The nearshore zone of the central basin of Lake Erie was classified by Stanford (1981) as mesotrophic with eutrophic tendencies close inshore, especially in harbors and at river mouth stations.

<u>Cleveland to Erie, Pennsylvania, Reach</u>. Incomplete data.

<u>Erie, Pennsylvania, to Buffalo, New York, Reach</u>. Monthly mean TAH bacteria values in 1978 increased from the spring to summer period, reaching a maximum in August and decreasing thereafter. The minimum mean value was recorded for the month of October (1.8×10^3/ml). Aside from the maximum monthly mean value calculated for August data ($\sim 9.0 \times 10^3$/ml), values in 1979 were relatively low and constant (Figure 5). Monthly mean values for this reach of the nearshore zone were in excess of 2000 organisms/ml for the six-month period where data was available in 1978. The eutrophic criterion was exceeded by one monthly mean ($\sim 9.0 \times 10^3$/ml) in 1979. This reach of the lake is mesotrophic with eutrophic conditions in harbors contributing to monthly means exceeding the criterion in 1978.

<u>Main Lake</u>. Monthly mean numbers of heterotrophic bacteria in each basin (sub-basin of the central basin) of the main lake study area are presented in Table 2. Median values of calculated monthly mean bacteria counts at main lake stations in the eastern basin and the eastern portion of the central basin range from 162 to 198/ml. Although monthly mean values sometimes exceed the eutrophic criterion of 200 organisms/ml in main lake water, the median of these values did not exceed the criterion. The latter observation leads to the conclusion that this portion of the lake may be classified as mesotrophic. Monthly mean densities in the western portion of the central basin slightly exceed the main lake criterion for eutrophic status (range 376-15479/ml). Main lake densities in Lake Erie exceed TAH bacteria densities reported in Lake Michigan (Rockwell, et al. 1980) by one or more levels of magnitude. In Lake Michigan, TAH bacteria densities ranged between 2 and 35/ml in the main lake and between 5 and 110/ml in the nearshore portions of the study area.

Overall, aerobic heterotroph densities decrease from west to east in Lake Erie. The decrease in mean densities is apparent in each month where data is available. In both the main lake and nearshore portions of the western basin, TAH bacteria densities were highest in the spring and lowest in the late summer months. Densities decreased with distance from shore. Highest densities (1.63×10^8/ml) in the western basin were recorded in the nearshore zone south of the Detroit River (Diamond et al. 1980).

A similar pattern of high monthly mean densities in the spring months and low densities in the summer months occurred in the western portion of the central basin nearshore zone. In contrast, TAH bacteria increased slightly from spring to late summer months in the main lake portion of the central basin. Densities in the nearshore zone of the central basin were highest inshore and decreased offshore. The pattern of lower monthly mean densities in the spring and fall months and higher monthly mean densities of TAH bacteria in the summer months was apparent in both the nearshore and the main lake portions of the eastern basin.

Fecal Coliform Bacteria/Fecal Streptococcal Bacteria

Fecal coliform bacteria and fecal streptococcal bacteria are normal flora of the intestinal tract of animals. Not endemic in lakewater, the occurrence of these forms can be traced to domestic sewage outfalls or runoff from animal lots. Densities of fecal coliforms and fecal streptococci in the nearshore zone were greatest at inshore stations, especially at tributaries. Densities decreased with increasing distance from the shoreline. The spatial distribution of fecal coliforms and fecal streptococcal bacteria was very similar throughout the study period. In general, monthly mean densities of fecal coliform bacteria exceeded monthly mean numbers of fecal streptococcal bacteria by one (1) order of magnitude. In Lake Michigan, fecal coliform densities in the nearshore zone were typically 1/100 ml and never exceeded 12/100 m (Rockwell et al. 1980). Densities in the nearshore zone from Detroit, Michigan, to Buffalo, New York were considerably higher.

In the nearshore portion of the western basin, densities of both fecal coliform and fecal streptococcal bacteria were highest along the Michigan shoreline south of the Detroit River. Monthly mean densities of fecal coliforms (Figure 6) and fecal streptococci (Figure 10) were lowest in the spring and late summer months and highest in the early summer during 1978.

Monthly mean densities of both fecal coliform and fecal streptococcal bacteria in the nearshore zone of the central basin were typically highest in the spring months and lowest in the late summer (Figures 7 and 11). High densities of both fecal bacterial types in the spring of the year are usually attributed to runoff events overloading municipal sewage plants served by combined storm/sanitary sewers. The high flow during peak spring runoff periods is bypassed into tributaries and the nearshore zone of the lake. Similar periods of shorter duration occur during the fall months.

Densities of fecal coliform and fecal streptococcal bacteria in the nearshore zone of the eastern basin were lowest in the late spring (Figures 9, 13 and 14) and highest in the late summer months of July and August. Fecal streptococcal densities along the north shore of the lake were lower (Figures 14-18), often by an order of magnitude, in comparison with monthly mean densities reported for reaches of the south shore (Figures 10-13).

When sufficient numbers of fecal coliform bacteria (FC) and fecal streptococcal bacteria (FS) are present in samples from a site, the ratio (FC/FS) of the two counts can be used to estimate the source of contamination. Ideally, samples should be taken very close to the source of fecal contamination. Intestinal flora have a low survival rate in ambient lake water and may become mixed with bacteria from other sources. As part of the nearshore intensive portion of the surveillance plan, samples were seldom collected close to a source of fecal contamination. As a result, most of the ratios (FC/FS) calculated represent mixed sources. Mixed source water and differential mortality rates of selected fecal coliforms and fecal streptococcal forms make valid application of the ratio difficult. In general, the majority of ratios calculated indicated contamination from non-human sources.

The International Joint Commission water quality objectives and the standards of several jurisdictions set an upper limit for fecal coliform bacteria of 200/100 ml. This objective was established as the safety level for secondary contact with lake water. Secondary contact involves such recreational activities as fishing and boating. The maximum number of violations of this objective occurred during the spring months in the nearshore zone. The most serious spot in the central basin nearshore zone was identified by Stanford (1981) as the mouth of the Cuyahoga River in Cleveland Harbor. Several beaches at Presque Isle State Park in Erie, Pennsylvania exceeded the objective during the late summer months (Table 1).

Total Coliform Bacteria

Total coliform bacteria data in the nearshore zone of the north shore was reported by the Ontario Ministry of the Environment. The limited frequency and extent of sampling in 1978 prevent any detailed discussion of the data. Monthly mean values of total coliform bacteria along four reaches of the Canadian shoreline are summarized in Figures 19-22. Monthly mean total coliform values are lowest along the central basin shoreline (Figure 20) and the western portion of the eastern basin (Figure 21). Highest monthly mean values were calculated for the shoreline of the western basin (Figure 19) and the eastern portion of the eastern basin (Figure 22).

Pseudomonas aeruginosa

Sampling efforts for *Pseudomonas aeruginosa* were confined to potential problem stations in the nearshore zone. In U.S. waters, samples were collected during 1978 only. A more extensive sampling program was conducted along the Canadian shoreline. In general, this effort indicates *P. aeruginosa* is not a problem in the nearshore zone of Lake Erie.

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TABLES

TABLE 1

FECAL COLIFORM BACTERIA AND FECAL STREPTOCOCCI BACTERIA DETERMINED AT LAKE ERIE TRIBUTARIES, WATER SUPPLY INTAKES AND BEACHES - 1978/1979

SITE	STATION (STORET NO.)	FC 1978 No./100 ml	FC 1978 MEAN (RANGE) /100 ml	FC 1979 No./100 ml	FC 1979 MEAN (RANGE) /100 ml	FS 1978 No./100 ml	FS 1978 MEAN (RANGE) /100 ml	FS 1979 No./100 ml	FS 1979 MEAN (RANGE) /100 ml	RATIO FC:FS 1978	RATIO FC:FS 1979
Huron (Ohio) Water Supply Intake	504040	11	0.54 (0-4)	1	0.0	11	51.82 (0-51.8)	1	0.0	0.06	--
Sandusky (Ohio) Water Supply Intake	504030	12	7.0 (1-53)	6	24.0 (1-100)	3	53 (0-159)	1	1.0	0.33	--
Lorain (Ohio) Water Supply Intake	504060	29	145.8 (0-900)	--	--	29	312.8 (0-4300)	--	--	0.9	--
Crown (Cleveland Ohio) Water Supply Intake	504090	--	--	10	4.6 (2-20)	--	--	10	4.65 (2-18)	--	1.17
Port Clinton (Ohio) Water Supply Intake	504020	12	57.5 (1-248)	10	71.3 (22-340)	--	--	--	--	--	--
Oregon (Ohio) Water Supply Intake	504240	10	4.9 (1-40)	5	47.8 (1-210)	1	1.0	2	30.5 (1-60.0)	--	0.58
Mentor-on-Lake (Ohio) Water Supply Intake	504130	52	36.9 (1-520)	10	155.15 (2-770)	49	29.7 (1-330)	10	67.0 (2-290)	1.64	3.45
Ashtabula (Ohio) Water Supply Intake	504160	--	--	10	14.1 (2-53)	--	--	10	12.55 (2-50)	--	1.99
Monroe (Michigan) Water Supply Intake	580048	4	10 (10)	3	36.7 (10-90)	4	10 (10)	3	26.7 (10-60)	1.0	1.17
Conneaut (Ohio) Water Supply Intake	504170	--	--	4	15.75 (2-35)	--	--	4	9.0 (2-17)	--	1.9
Detroit River Range 3.9 2500 ft. from West Shore	820011	9	1402.2 (10-7000)	13	716.9 (10-6000)	--	--	--	--	--	--
Detroit River Range 3.9 5500 ft. from West Shore	820014	9	1515.6 (100-9600)	13	758.5 (10-8700)	--	--	--	--	--	--
Detroit River Range 3.9 7500 ft. from West Shore	820016	9	781.1 (30-4300)	13	372.3 (10-3800)	--	--	--	--	--	--
Detroit River Range 3.9 11500 ft. from West Shore	820018	9	374.4 (20-2800)	13	121.5 (10-1100)	--	--	--	--	--	--
Detroit River Range 3.9 9500 ft. from West Shore	820017	9	430.0 (10-3000)	13	206.9 (10-2100)	--	--	--	--	--	--
Detroit River Range 3.9 14500 ft. from West Shore	000024	9	466.7 (20-2800)	13	56.9 (10-510)	--	--	--	--	--	--
Detroit River Range 3.9 15000 ft. from West Shore	000025	9	238.9 (10-800)	13	30.0 (10-270)	--	--	--	--	--	--
Detroit River Range 3.9 16200 ft. from West Shore	000026	9	107.8 (10-400)	13	48.5 (10-220)	--	--	--	--	--	--
Detroit River Range 3.9 16500 ft. from West Shore	000027	9	115.6 (10-400)	13	66.2 (10-340)	--	--	--	--	--	--
Detroit River Range 3.9 18500 ft. from West Shore	000029	9	1083.8 (10-8500)	12	362.5 (30-1700)	--	--	--	--	--	--
Erie (Pennsylvania) Water Supply Intake	WQN0601	4	10.0 (10.0)	2	7 (4-10)	--	--	--	--	--	--
Erie (Pennsylvania) North of Gilson Avenue	WQN0622	2	33.0 (12-54)	1	10 (10)	--	--	--	--	--	--
Raccoon Creek Beach; Erie County, Pa.	--	7	70 (4-240)	14	52.0 (4-168)	--	--	--	--	--	--
Elk Creek Beaches; Erie County, Pa.	--			5	24.4 (4-50)						

TABLE 1 CONT.

FECAL COLIFORM BACTERIA AND FECAL STREPTOCOCCI BACTERIA DETERMINED AT LAKE ERIE TRIBUTARIES, WATER SUPPLY INTAKES AND BEACHES - 1978/1979

SITE	STATION (STORET NO.)	FC 1978 No./100 ml	FC 1978 MEAN (RANGE) /100 ml	FC 1979 No./100 ml	FC 1979 MEAN (RANGE) /100 ml	FS 1978 No./100 ml	FS 1978 MEAN (RANGE) /100 ml	FS 1979 No./100 ml	FS 1979 MEAN (RANGE) /100 ml	RATIO FC:FS 1978	RATIO FC:FS 1979
Trout Run Beach; Erie County, Pa.	--	3	97 (4-240)	5	123.2 (4-240)	--	--	--	--	--	--
Eagley Park Beach; Erie County, Pa.	--	1	172	3	27.3 (4-76)	--	--	--	--	--	--
Camp Lambec Beach; Erie County, Pa.	--	2	40 (12-68)	3	24.0 (4-64)	--	--	--	--	--	--
Camp Judson Beach; Erie County, Pa.	--	2	42 (4-80)	3	57.3 (4-96)	--	--	--	--	--	--
Camp Fitch Beach; Erie County, Pa.	--	1	8	7	41.7 (4-140)	--	--	--	--	--	--
Walnut Creek Beach; Erie County, Pa.	--	--	--	6	8 (4-68)	--	--	--	--	--	--
Powell Avenue Beach; Erie County, Pa.	--	--	--	1	90	--	--	--	--	--	--
Kelso Beach; Erie County, Pa.	--	2	53.5 (3-104)	3	15.3 (10-24)	--	--	--	--	--	--
Presque Isle Beaches; Erie County, Pa.	--	31	51.9 (4-240)		117.5 (4-1940)	--	--	--	--	--	--
Walnut Creek Tributary; Erie County, Pa.	WQN0602	3	180.0 (10-450)	4	167.5 (10-340)	--	--	--	--	--	--
Elk Creek Tributary; Erie County, Pa.	WQN0604	4	22.5 (10-60)	4	2105 (10-6000)	--	--	--	--	--	--
Sixteen Mile Creek, Trib. Erie County, Pa.	WQN0602	4	373.75 (10-940)	4	1490.0 (60-5300)	--	--	--	--	--	--
Chautauqua Blvd. Beach; Erie County, Pa.	--	3	72.0 (12-168)	1	4	--	--	--	--	--	--
Halley Street Beach; Erie County, Pa.	--	3	142.6 (28-240)	2	108.0 (4-212)	--	--	--	--	--	--
Cowell's Beach; Erie County, Pa.	--	--	--	2	34.0 (32-36)	--	--	--	--	--	--
Shade's Beach; Erie County, Pa.	--	6	56.6 (4-180)	5	1208.4 (4-6000)	--	--	--	--	--	--
Shorewood Beach; Erie County, Pa.	--	3	12.0 (4-20)	2	4 (4)	--	--	--	--	--	--
Freeport Beach; Erie County, Pa.	--	5	74.4 (4-140)	7	42.5 (4-148)	--	--	--	--	--	--
Northeast Boat Access; Erie County, Pa.	--	--	--	3	44 (4-88)	--	--	--	--	--	--
Twenty Mile Beach; Erie County, Pa.	--	--	--	3	95.6 (12-240)	--	--	--	--	--	--

TABLE 2

MONTHLY MEANS FOR TOTAL AEROBIC HETEROTROPHIC BACTERIA IN THE MAIN LAKE PORTION OF THE WESTERN, CENTRAL AND EASTERN BASINS

		WESTERN BASIN			WEST CENTRAL BASIN			EAST CENTRAL BASIN			EASTERN BASIN		
YEAR	MONTH	NO.	MEAN	SE	NO.	MEAN	SE	NO.	MEAN	SE	NO.	MEAN	SE
1978	5	34	869	583	26	307	114	41	31	4	26	97	12
	6	15	990	302	54	500	182	86	247	55	83	180	23
	7	33	883	93	33	316	62	43	163	26	41	172	31
	8				8	188	232	6	222	43	2	320	80
	9	36	376	58	74	273	35	---	---	---	58	250	24
	10	54	1689	571	81	294	76	110	141	9	116	197	19
	11	43	540	150	35	206	34	51	119	12	55	83	9
1979	4	24	15479	6332									
	5	35	1316	454	42	100	32	56	54	17	58	34	3
	6				--	---	---	---	---	---	---	---	--
	7	50	580	91	26	335	59	43	244	26	57	298	29
	8	42	819	214	48	642	82	14	442	106	---	---	--
	9	34	1065	403	47	569	276	59	529	105	61	233	22
	10	34	837	337	40	199	18	49	199	20	54	122	11
	11	34	667	218	36	191	51	45	62	12	46	144	46

FIGURES

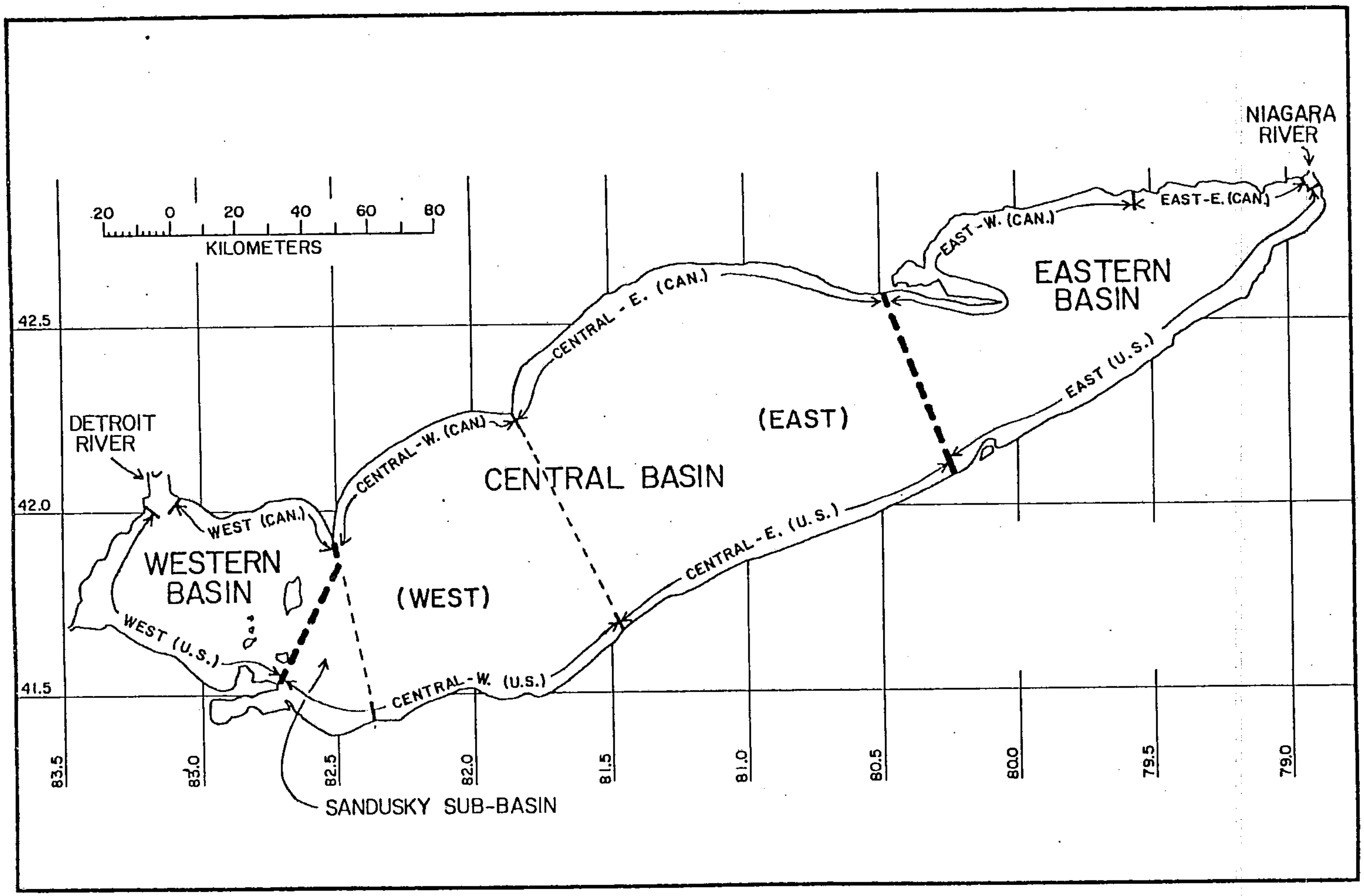

Figure 1. Delineation of Lake Erie Nearshore Reaches.

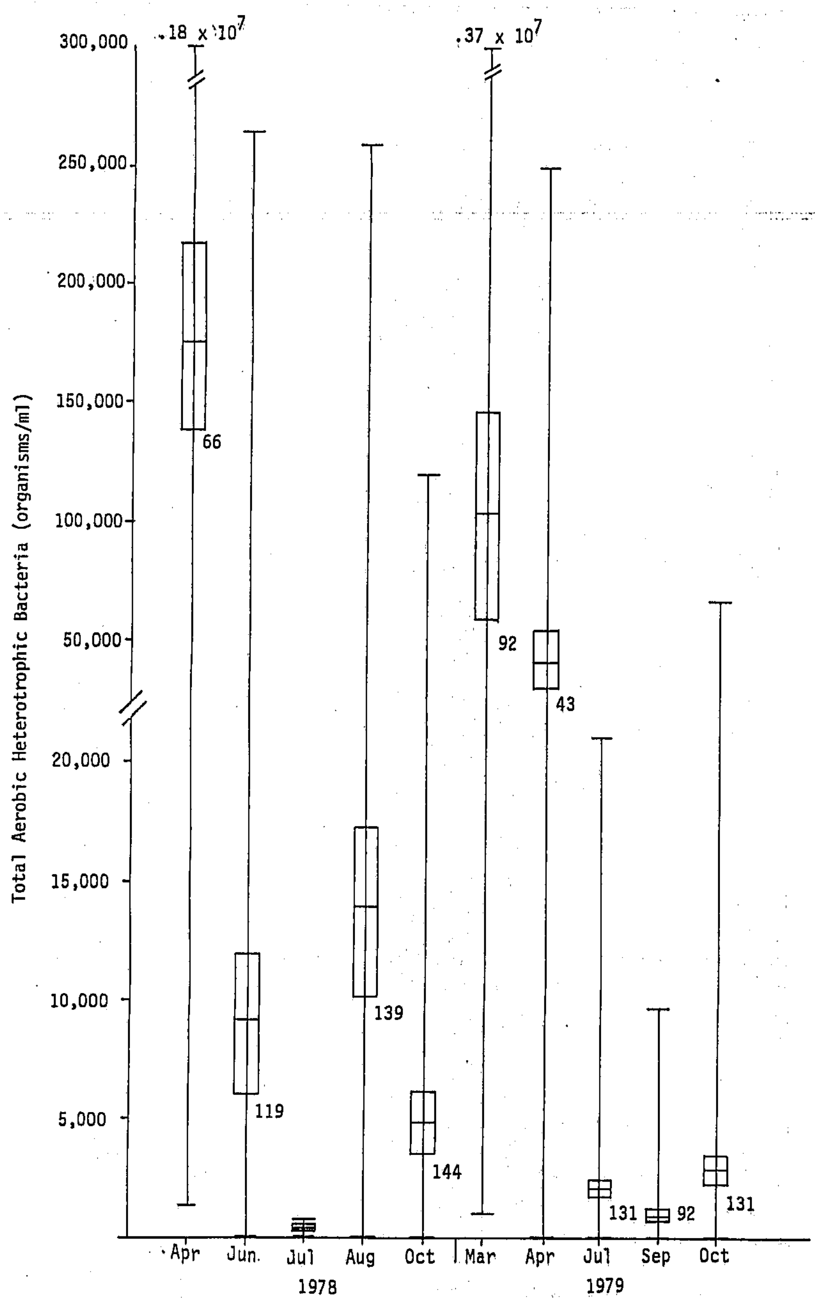

Figure 2. Monthly Mean Values of Aerobic Heterotrophs in the Nearshore Zone of the Western Basin, Point Mouillee, Michigan to Marblehead, Ohio.

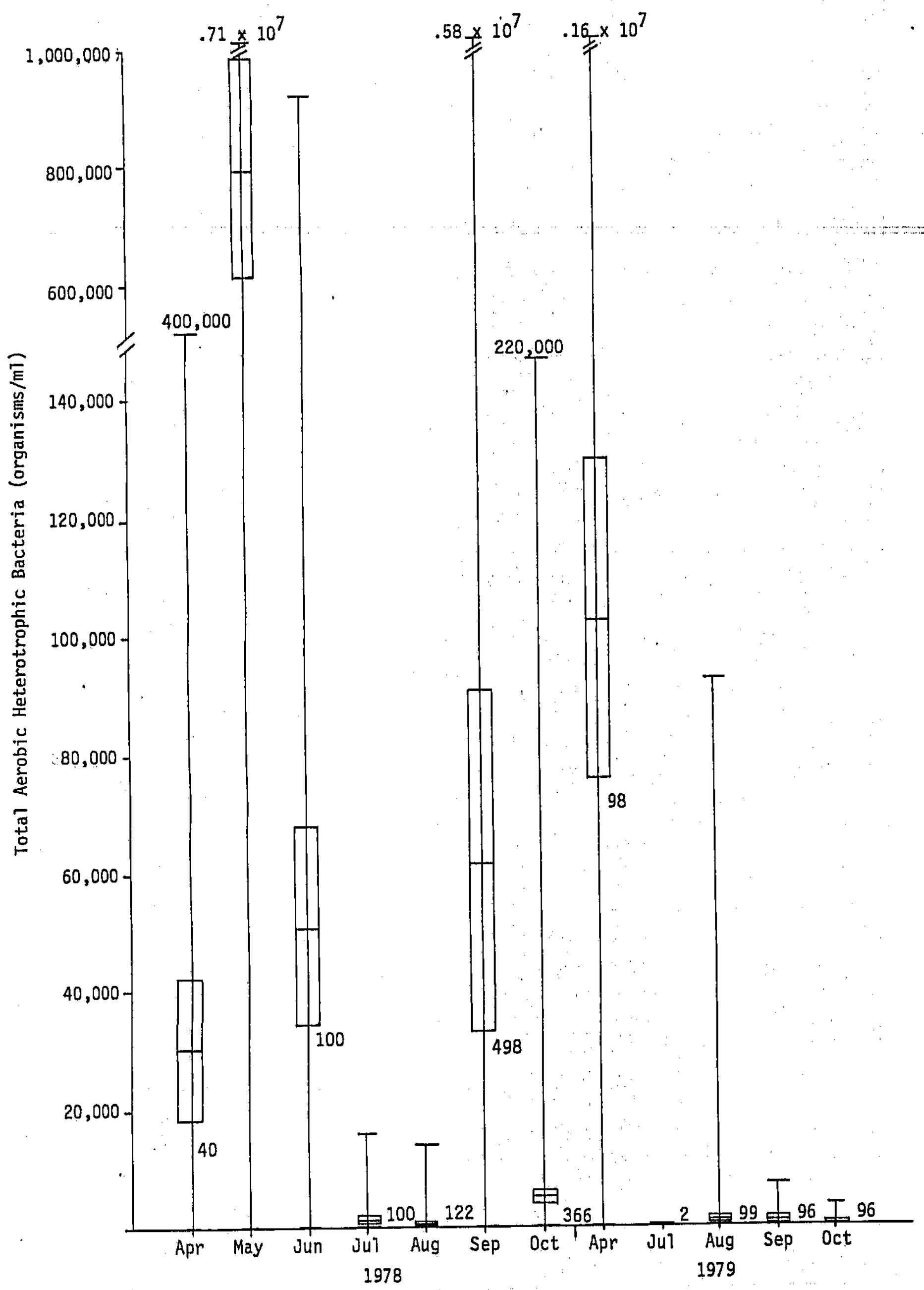

Figure 3. Monthly Mean Values of Aerobic Heterotrophs in the Nearshore Zone of the Western Portion of the Central Basin, Marblehead to Cleveland, Ohio.

(to be completed)

Figure 4. Monthly Mean Values of Aerobic Heterotrophs in the Nearshore Zone of the Eastern Portion of the Central Basin, Cleveland, Ohio to Erie, Pennsylvania.

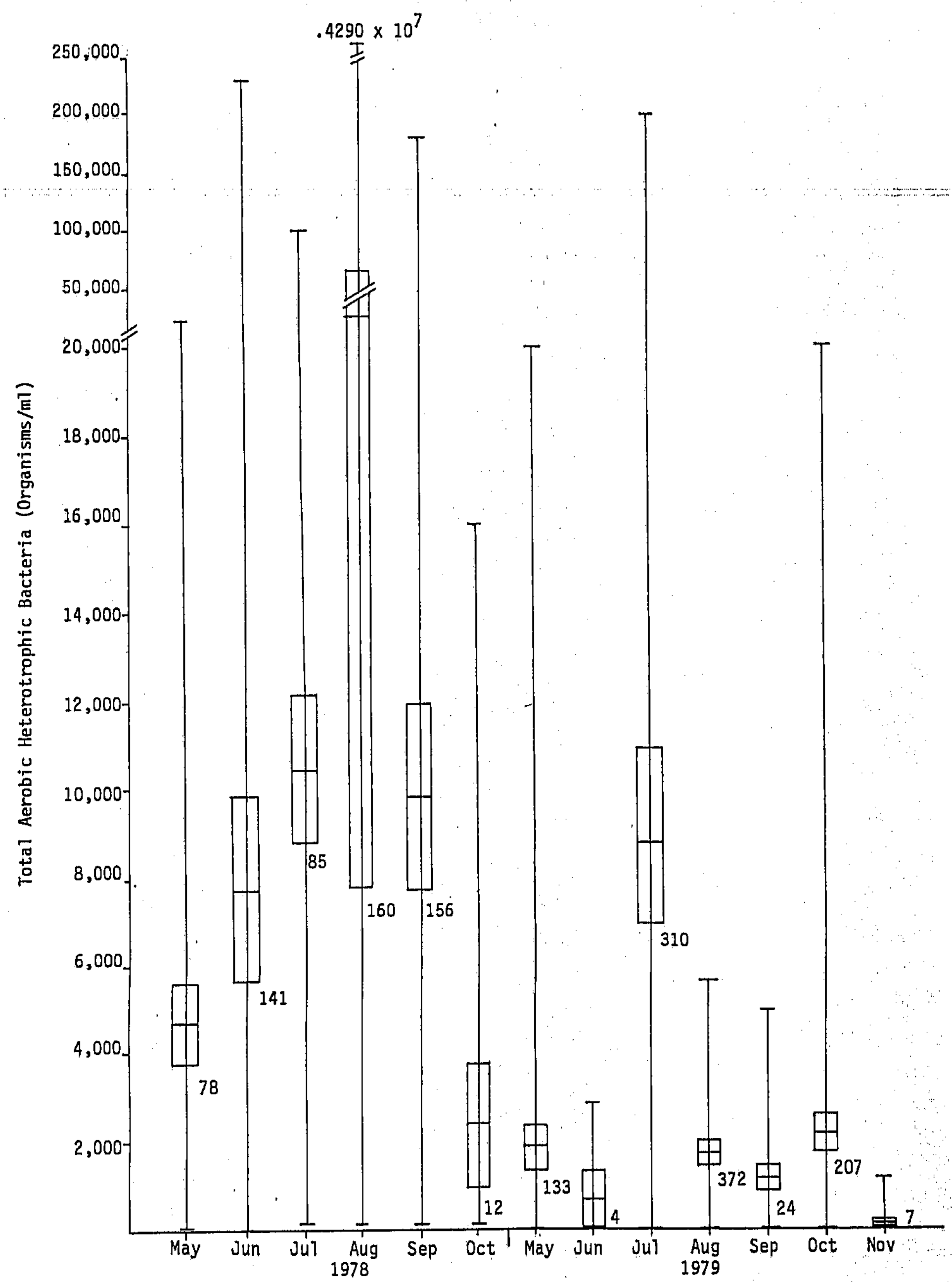

Figure 5. Monthly Mean Values of Aerobic Heterotrophs in the Nearshore Zone of the Eastern Basin, Erie, Pennsylvania to Buffalo, New York.

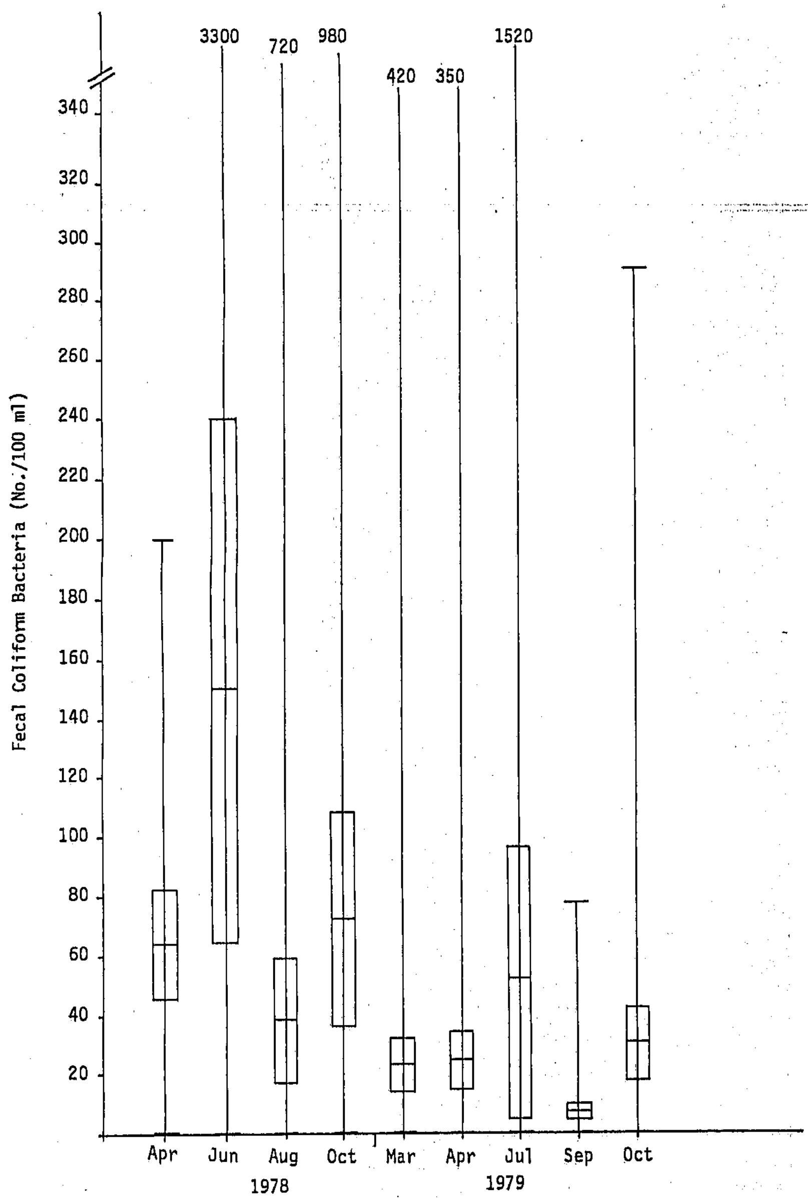

Figure 6. Monthly Mean Values of Fecal Coliform Bacteria in the Nearshore Zone of the Western Basin, Point Mouillee, Michigan to Marblehead, Ohio.

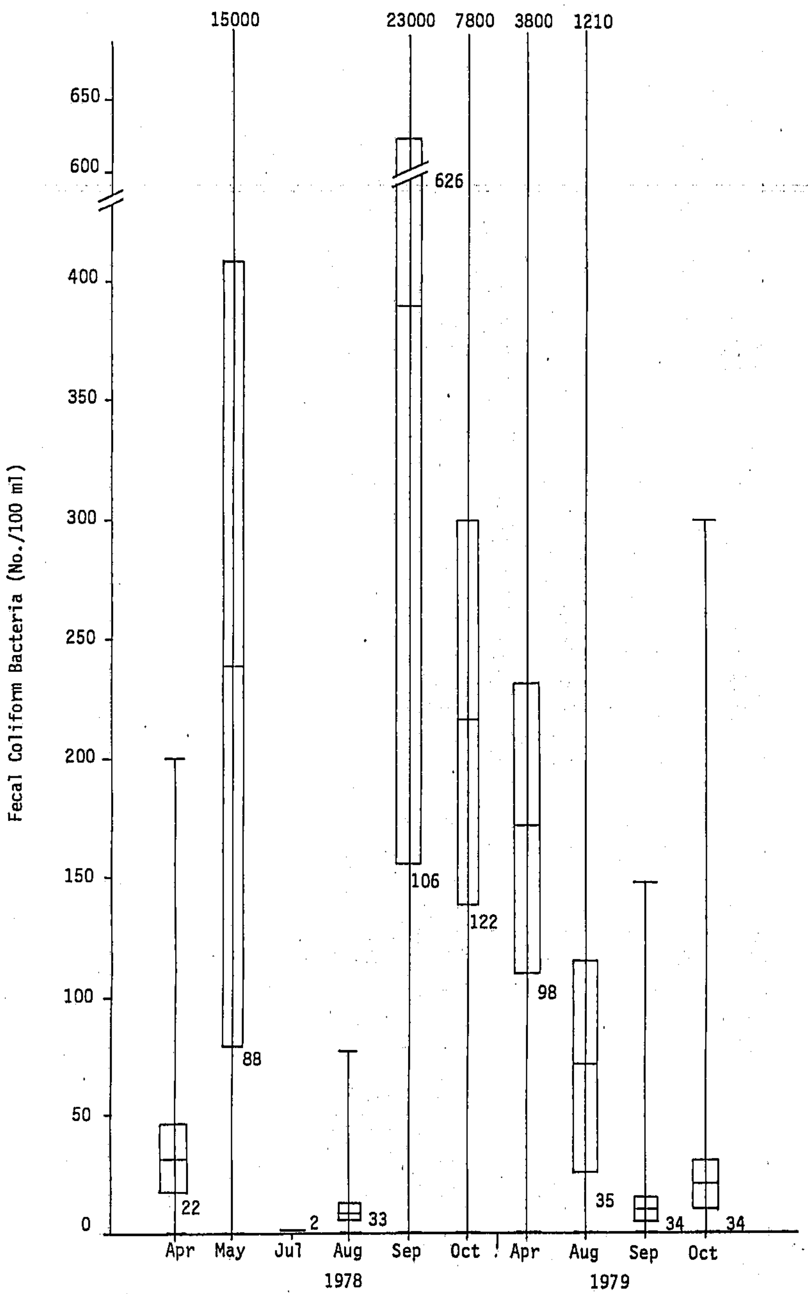

Figure 7. Monthly Mean Values of Fecal Coliform Bacteria in the Nearshore Zone of the Western Central Basin, Sandusky to Cleveland, Ohio.

(to be completed)

Figure 8. Monthly Mean Values of Fecal Coliform Bacteria in the Nearshore Zone of the Eastern Central Basin, Cleveland, Ohio to Erie, Pennsylvania.

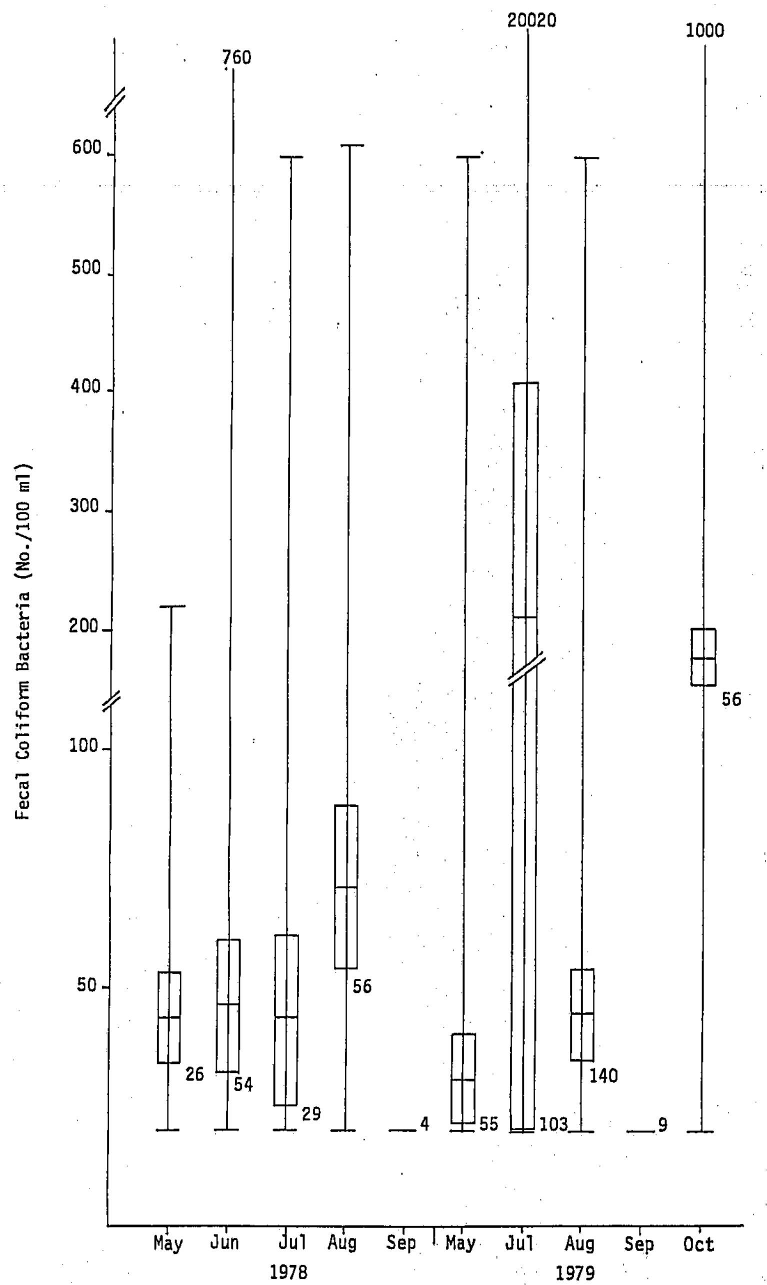

Figure 9. Monthly Mean Values of Fecal Coliform Bacteria in the Nearshore Zone of the Eastern Basin, Erie, Pennsylvania to Buffalo, New York.

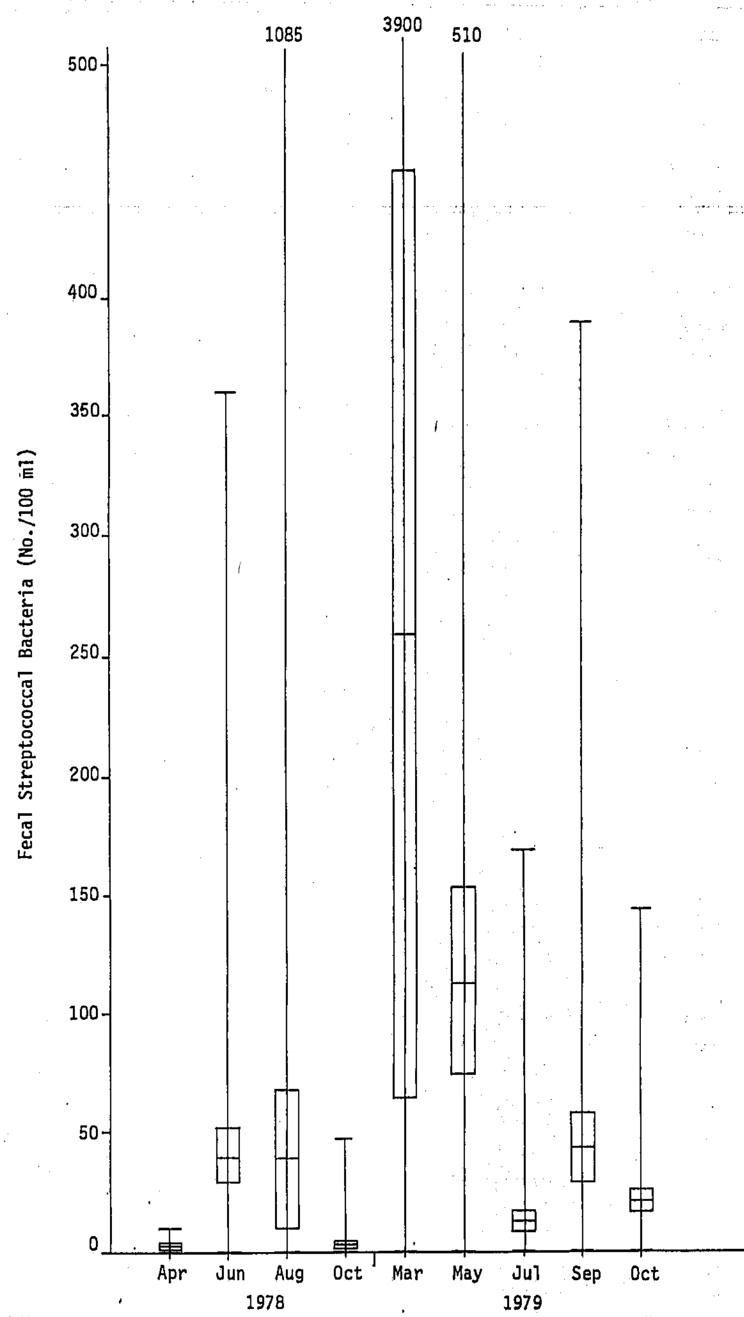

Figure 10. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Western Basin, Point Mouillee, Michigan to Marblehead, Ohio.

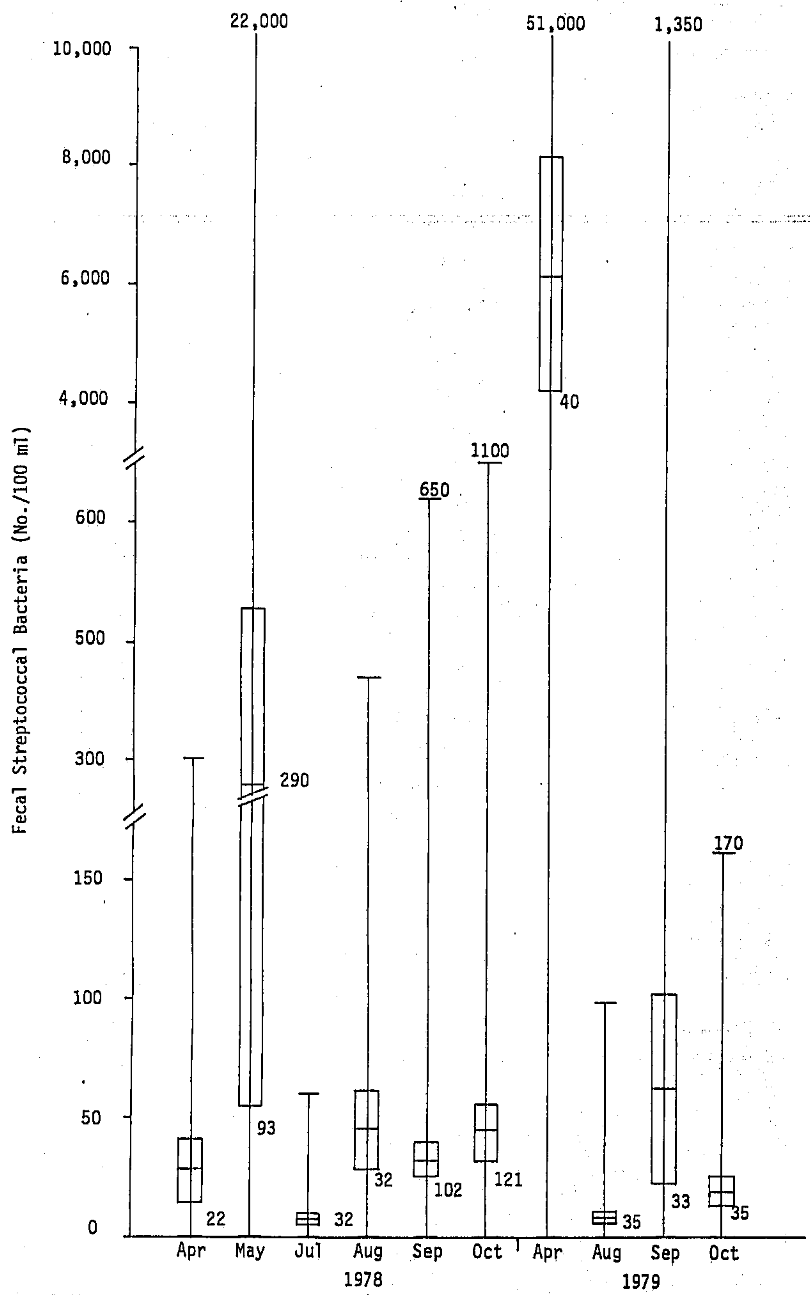

Figure 11. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Western Portion of the Central Basin, Marblehead to Cleveland, Ohio.

(to be completed)

Figure 12. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Eastern Portion of the Central Basin, Cleveland, Ohio to Erie, Pennsylvania.

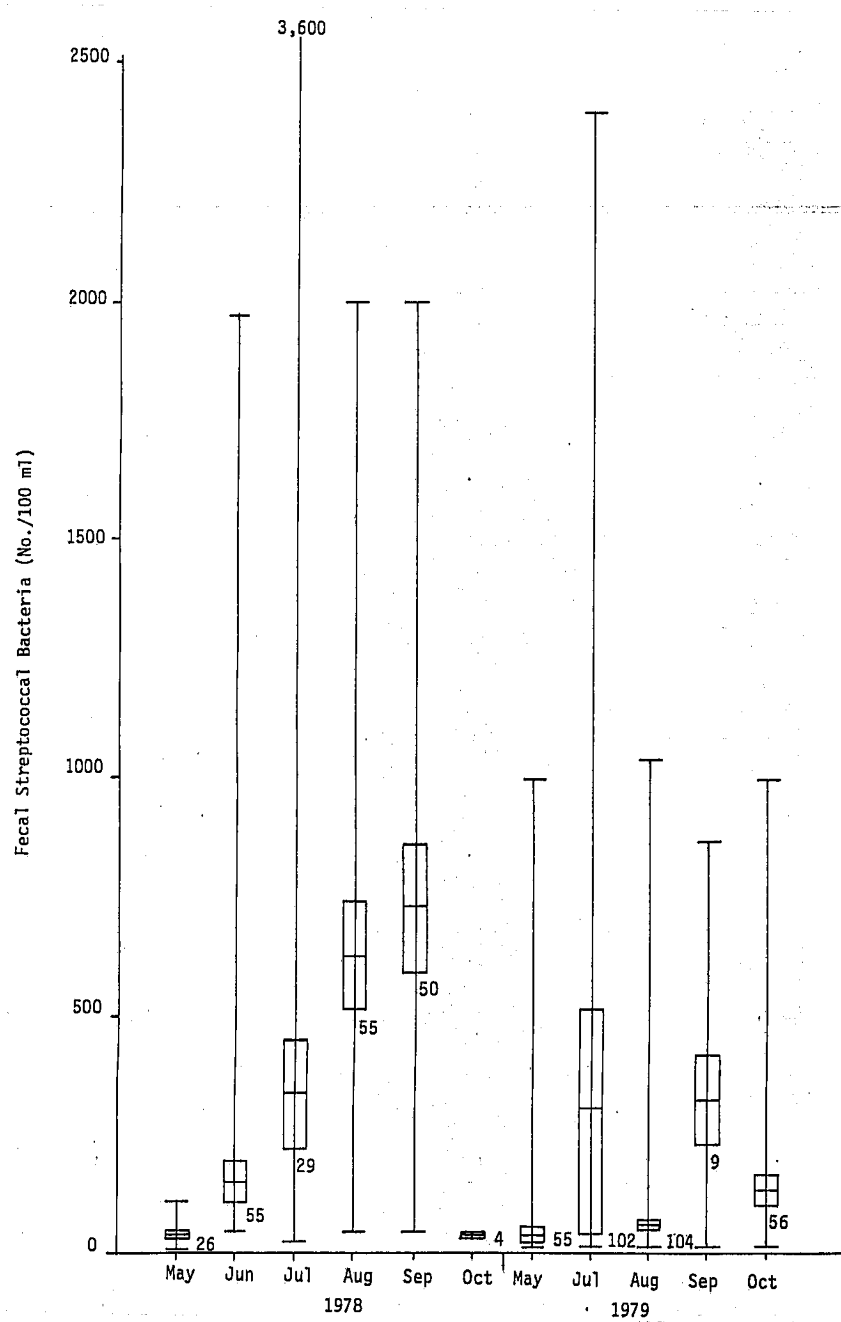

Figure 13. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Eastern Basin, Erie, Pennsylvania to Buffalo, New York.

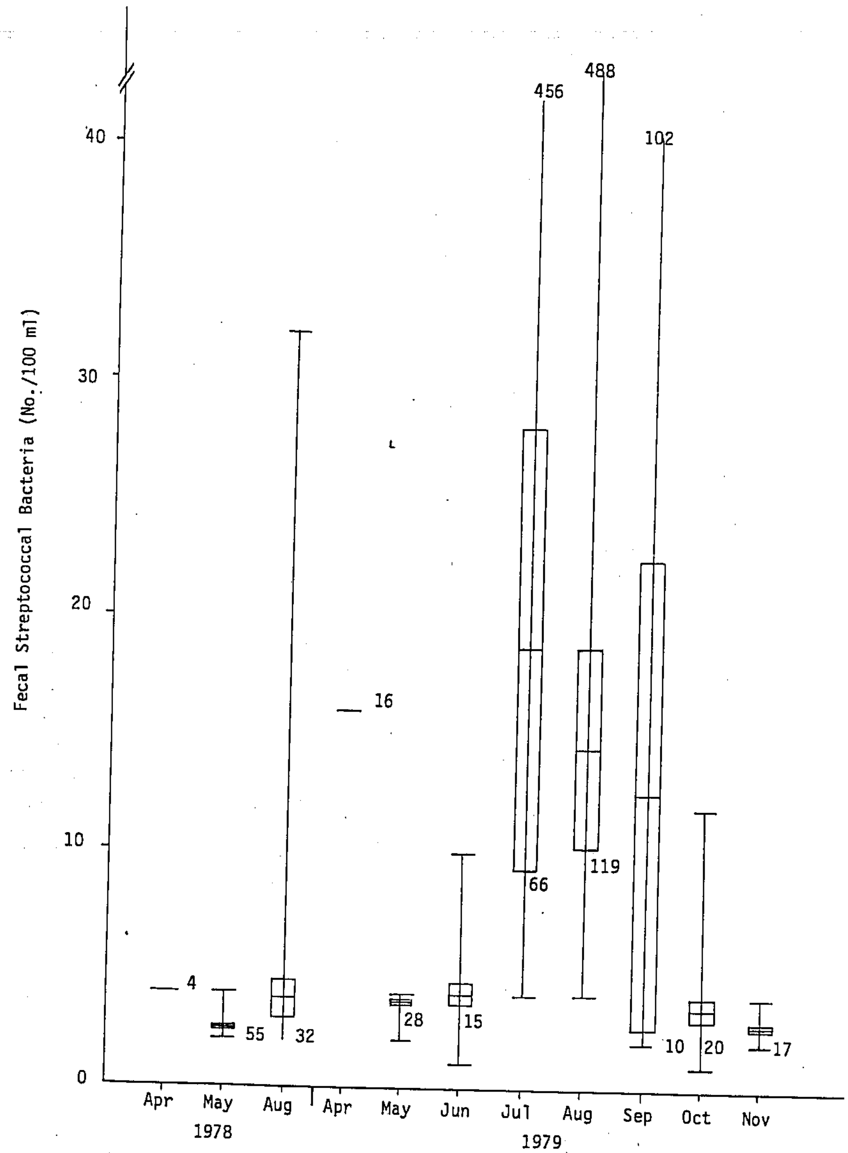

Figure 14. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Eastern Basin, Port Maitland, Ontario ot Buffalo, New York.

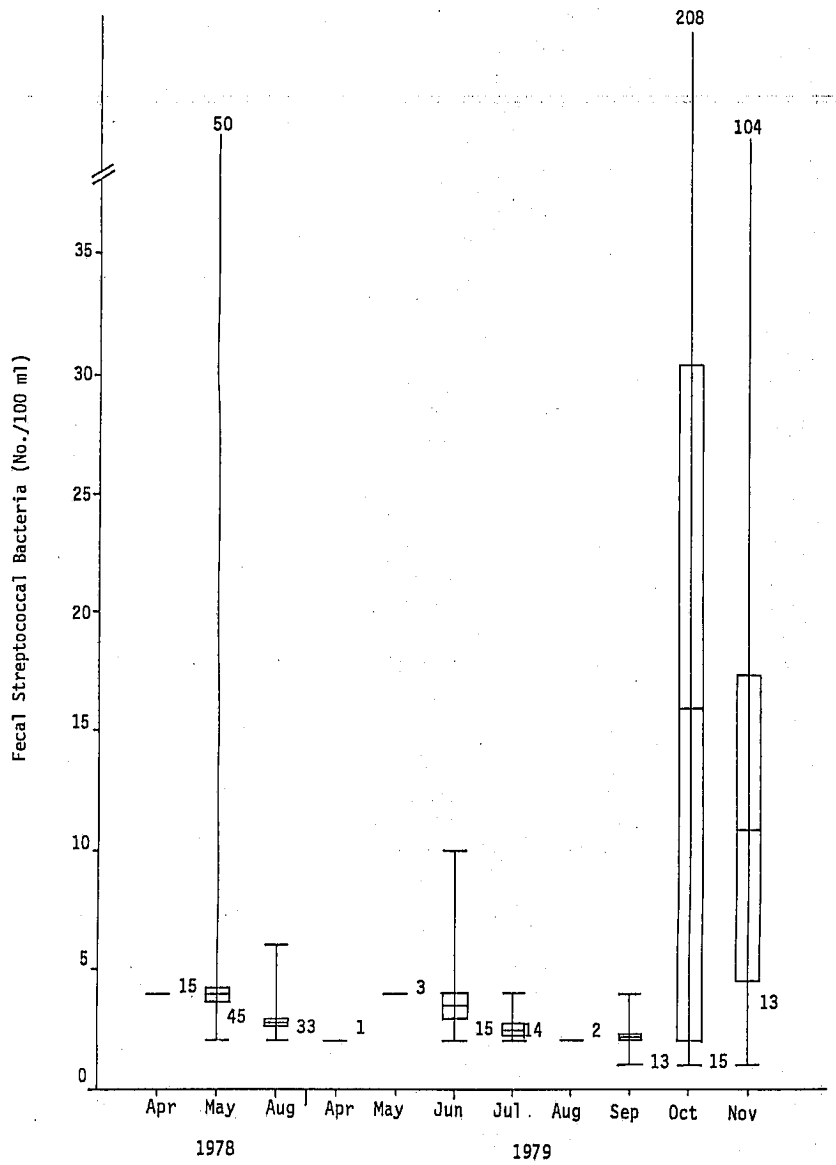

Figure 15. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Eastern Basin, Long Point to Port Maitland, Ontario.

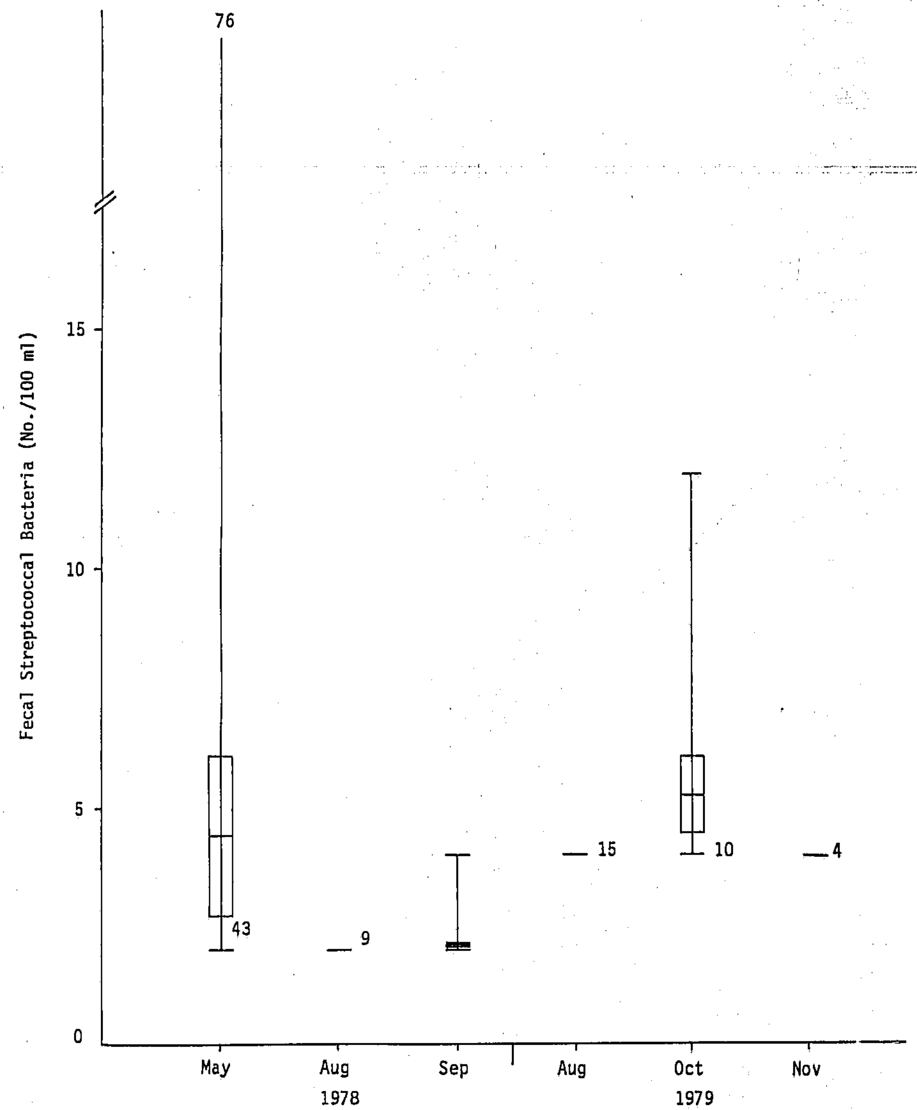

Figure 16. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Central Basin, Rondeau Harbor to Long Point , Ontario.

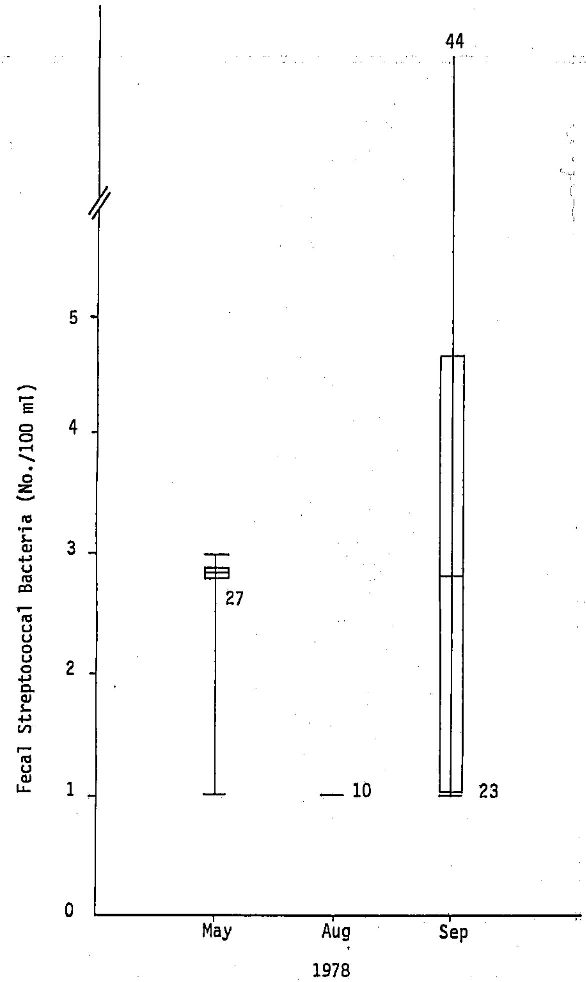

Figure 17. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Central Basin, Point Pelee to Rondeau Harbor, Ontario.

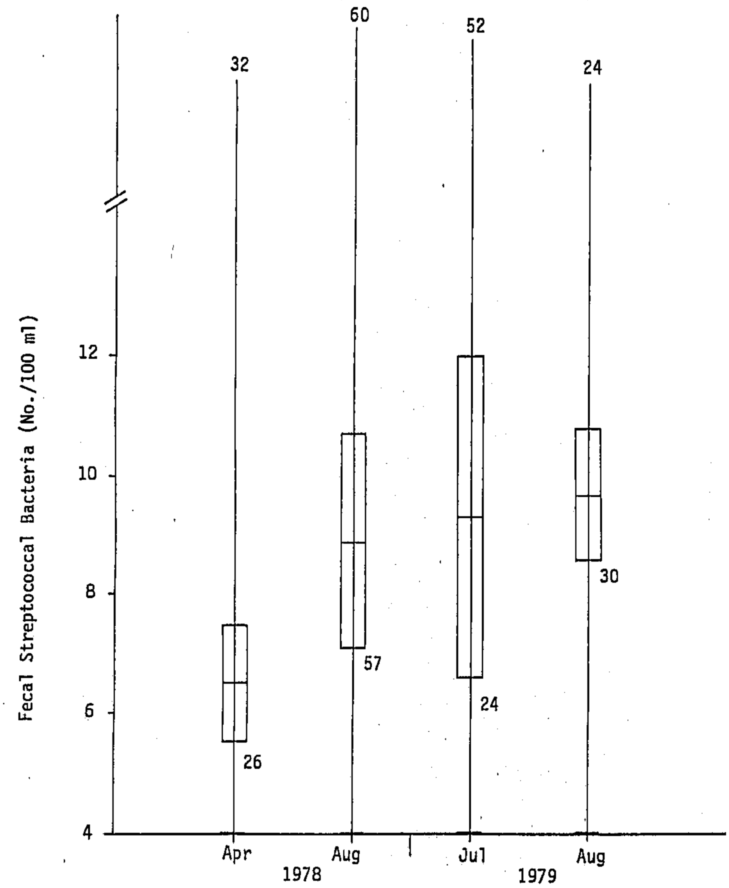

Figure 18. Monthly Mean Values of Fecal Streptococci in the Nearshore Zone of the Western Basin, Windsor to Point Pelee, Ontario.

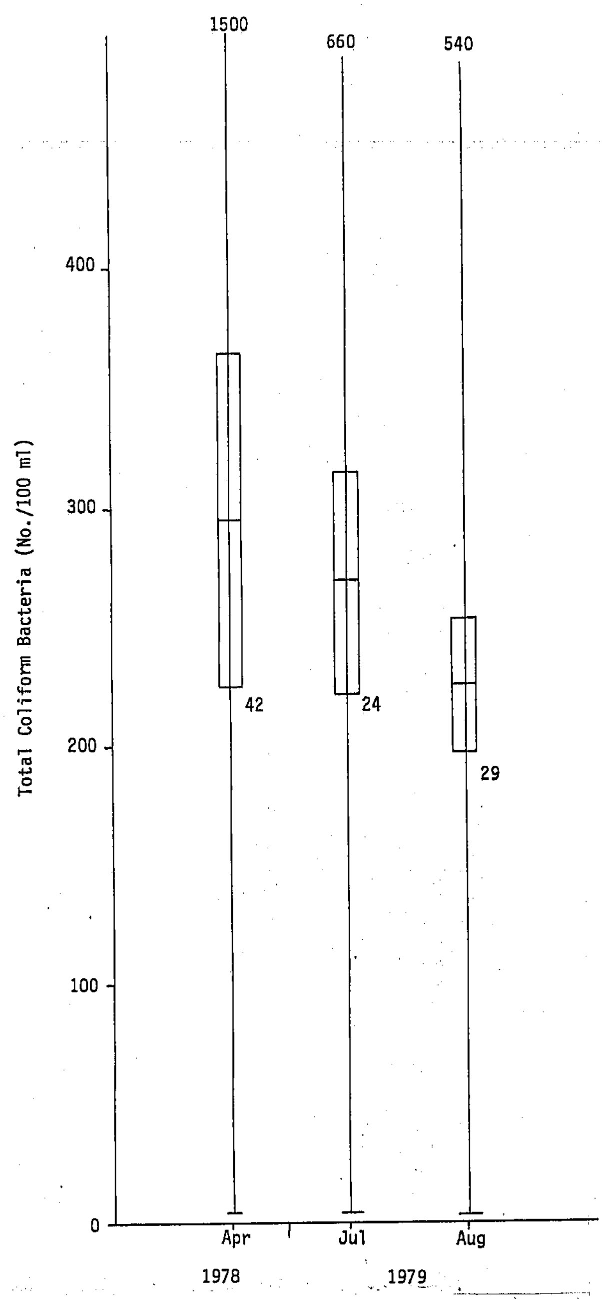

Figure 19. Monthly Mean Values of Total Coliform Bacteria in the Nearshore Zone of the Western Basin, Windsor to Point Pelee, Ontario.

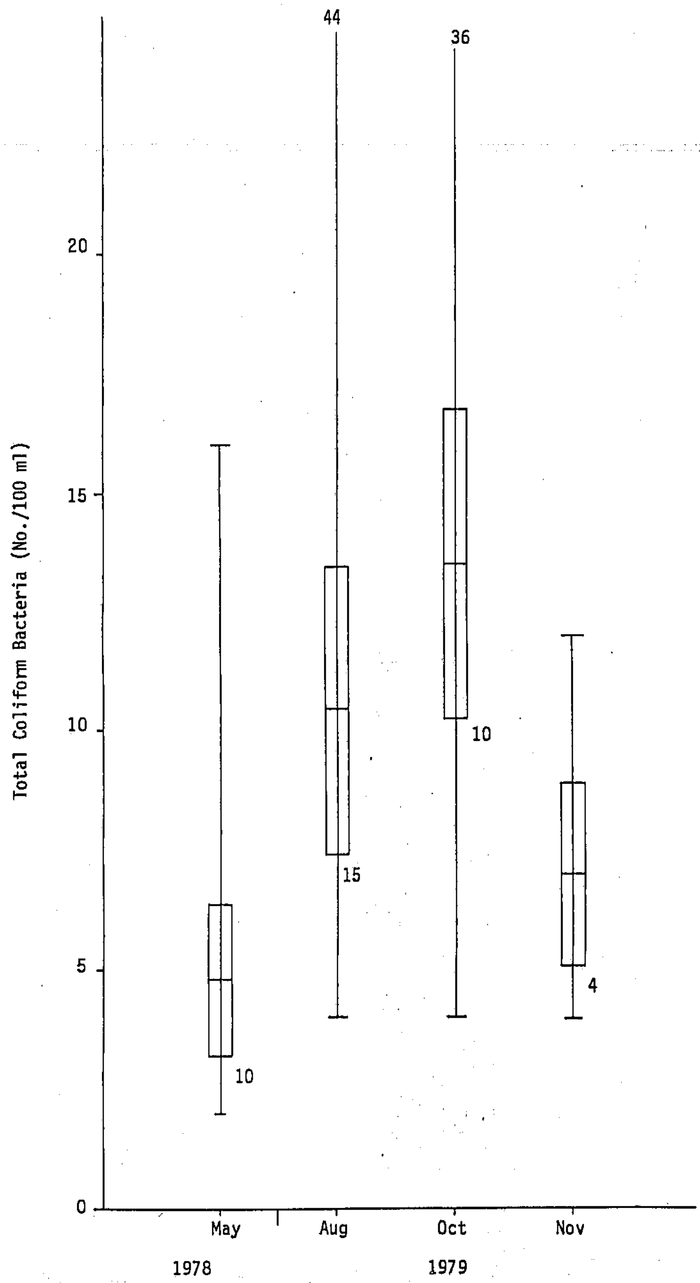

Figure 20. Monthly Mean Values of Total Coliform Bacteria in the Nearshore Zone of the Central Basin, Rondeau to Long Point, Ontario.

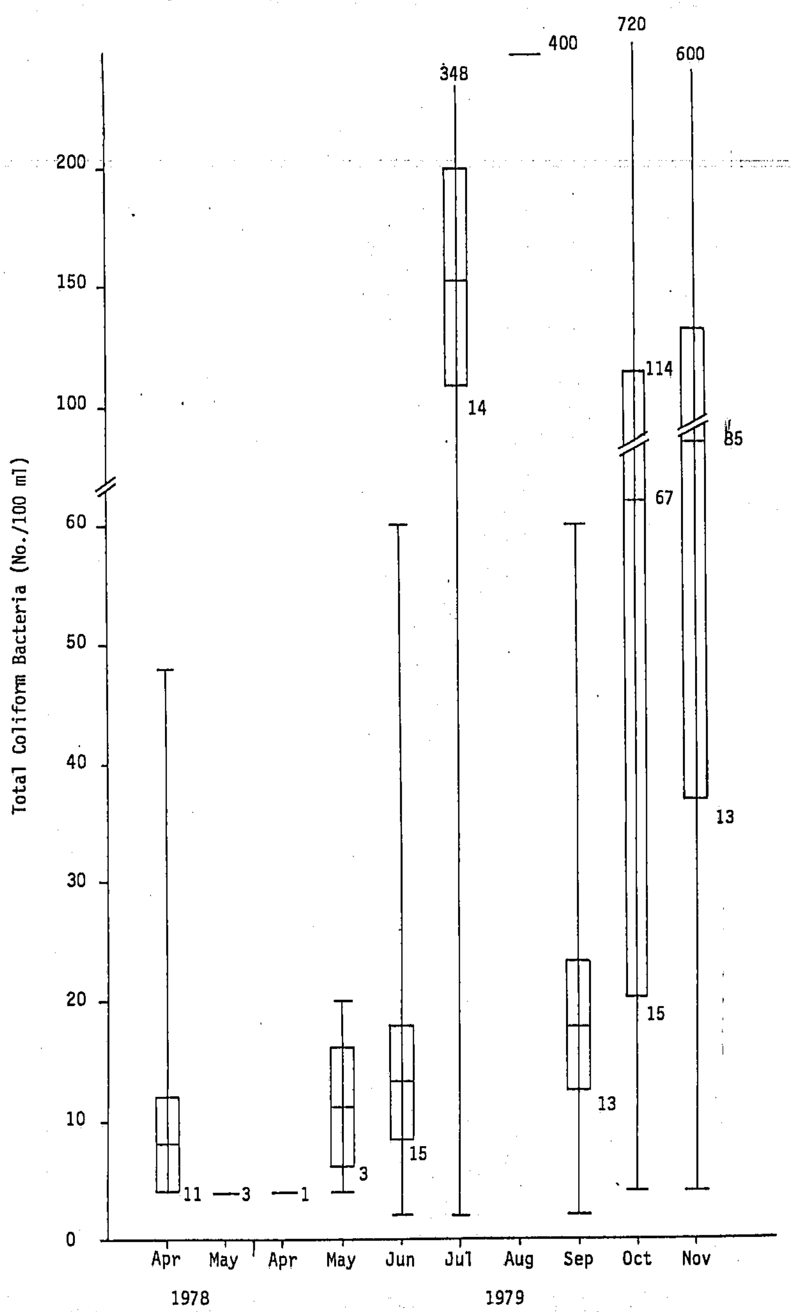

Figure 21. Monthly Mean Values of Total Coliform Bacteria in the Nearshore Zone of the Eastern Basin, Long Point to Port Maitland, Ontario.

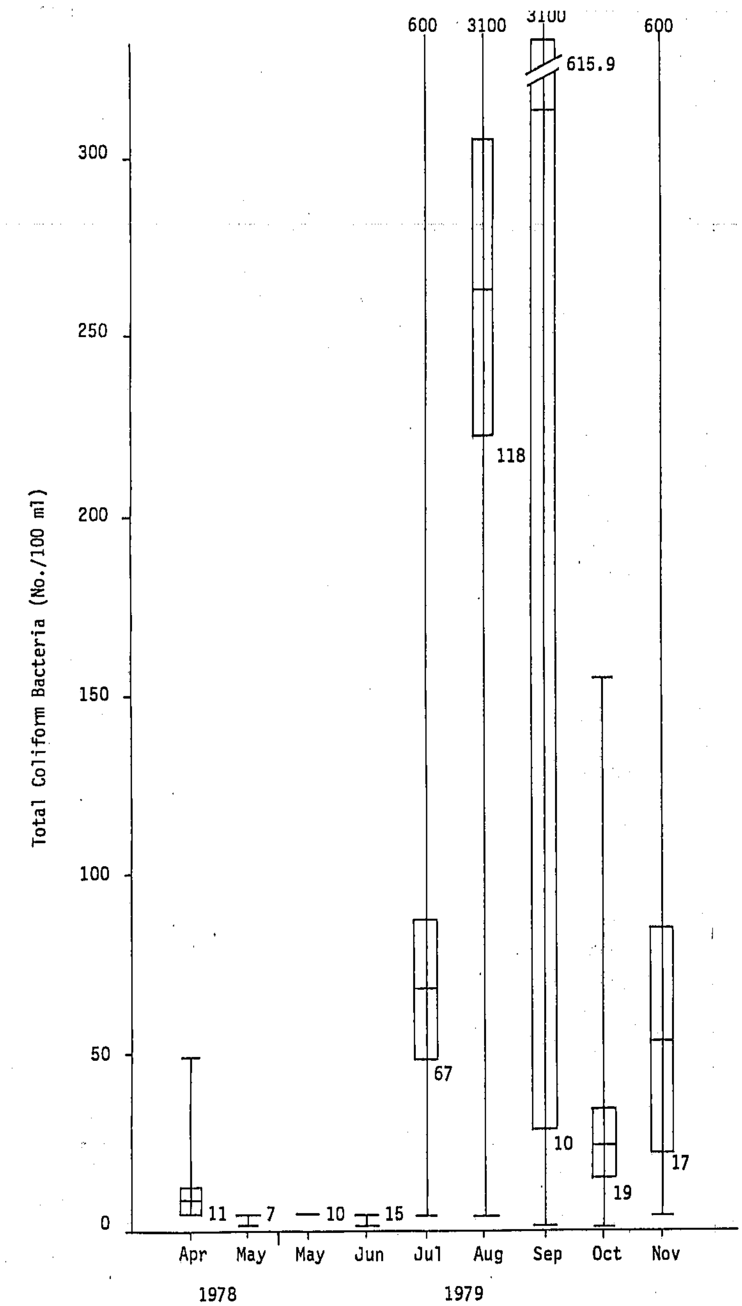

Figure 22. Monthly Mean Values of Total Coliform Bacteria in the Nearshore Zone of the Eastern Basin, Port Maitland, Ontario to Buffalo, New York.