THE

ONTARIO WATER RESOURCES

COMMISSION

REPORT ON

BIOLOGICAL SURVEY

OF

OTTER LAKE

(NORTHERN PORTION)

1966

by

M. J. German

Biology Branch

September 1967

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SUMMARY AND CONCLUSIONS

Prior to the summer of 1966, the northern section of Otter Lake was the receiving water for metal plating wastes from Canadian Motor Lamp Company Limited. During the summer of 1966, wastes from this plant were redirected to sediment ponds which provide complete retention.

A biological survey of Otter and Oastler Lake was carried out in October of 1966. Twenty-one stations were examined for mud and water chemistry as well as bottom fauna.

Chemical analyses of the water samples indicated that the retention ponds were functioning satisfactorily. Only trace amount of chromium (0.01 ppm) were detected and these occurred at only 6 of the 21 sampling stations. Much larger concentrations were detected as precipitate chromium in the bottom sediments. Total chromium concentrations ranged between 8 and 3470 ppm. These values indicated a substantial degree of previous exposure to chromium. Maximum concentrations of 1195 and 3470 ppm total chromium occurred at station 16 and 17 situated adjacent to the former discharge from Canadian Motor Lamp Company Limited. An impoverished bottom fauna was evident at these locations. No critical short-term effects on the bottom fauna were evident at the remaining sampling locations.

While the aquatic populations of the lake do not appear to have been altered to a large extent, it is imperative that the settling ponds be maintained in good order to ensure that there will be no further impairment of the waters of Otter and Oastler Lake as a result of contamination by chromium or other wastes.

INTRODUCTION

A biological survey of the northern section of Otter Lake was undertaken by the Biology Branch on October 19, 1963, at the request of the Division of Industrial Wastes. Biological parameters were selected for study since the source of pollution had been discontinued prior to the request for water quality information. Biological parameters have the ability to integrate water quality over a period of several months prior to the survey, as well as to provide direct evidence of damage owing to water pollution.

DESCRIPTION OF OTTER LAKE

Otter Lake is situated in the township of Foley, five miles south of Parry Sound. The lake is divided into a larger southern portion and a smaller northern portion by the Otter Lake Narrows; stoplogs at this location control the level of the southern part of the lake. Only the smaller northern portion will be considered in this report.

Flow from Otter Lake runs northwest via the Boyne River into Oastler Lake and eventually into Georgian Bay. The northern portion of the lake is approximately one mile long and has an average width of less than half a mile. Its maximum measured depth is 17 feet. Several private cottages and three commercial tourist camps are located along the shoreline. Situated on the north-eastern shore of the lake is Canadian Motor Lamp Company Ltd., a chromium plating plant.

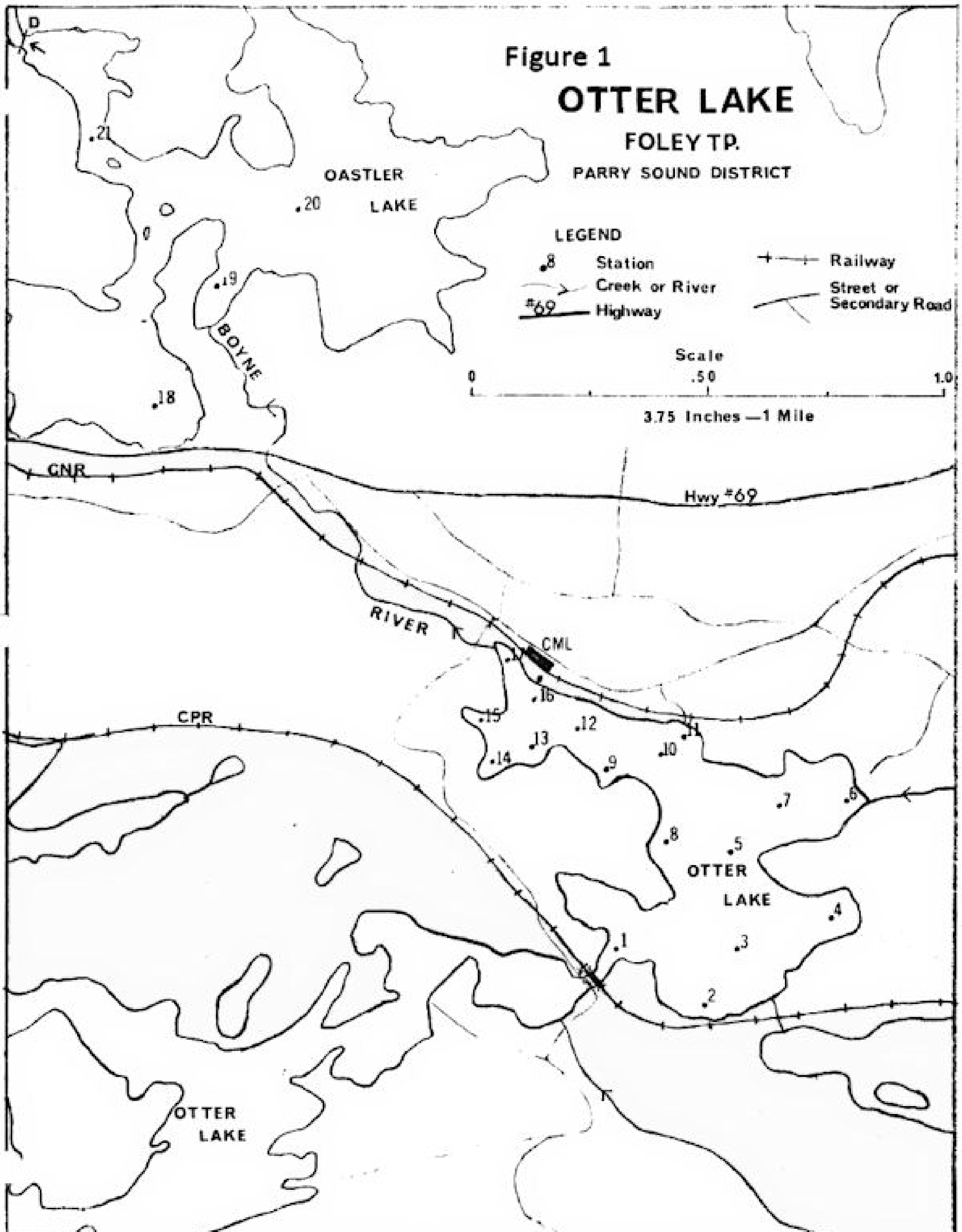
Figure 1
OTTER LAKE
FOLEY TP.
PARRY SOUND DISTRICT
LEGEND
.8 Station
Creek or River
#69 Highway
Railway
Street or Secondary Road
Scale
0
.50
1.0
3.75 Inches — 1 Mile
D
.21
OASTLER
LAKE
.20
.19
BOYNE
.18
CNR
Hwy #69
RIVER
CML
.16
.15
.12
.13
.14
.11
.10
.9
.7
.6
.8
.5
OTTER
LAKE
.4
.1
.3
.2
CPR
OTTER
LAKE

Prior to the summer of 1966, chromium. wastes were directly to the lake. Subsequently, these wastes were redirected to lagoons, thereby limiting access of chromium to the lake to seepage and possible overflows.

METHODS

Seventeen locations on the northern portion of Otter Lake and 4 locations on Oastler Laze were selected to provide samples of water and mud for chemical analyses and to monitor bottom faunal communities. Sampling locations are illustrated in Figure 1. The methods employed are outlined hereafter.

Water Chemistry

Water samples were secured from each station with a Kemmerer water sampler.

The Chemistry Branch of the Commission performed analyses for suspended and dissolved solids, pH, hardness and total chromium.

Mud Samples

Single 4-ounce bottles of mud were secured from Ekman dredge samples at each station. Samples were air dried and turned over to the Chemistry Branch for determinations of total chromium and per cent organic matter.

Bottom Fauna

Single dredge samples were employed to obtain 81 square inches of the bottom sediments at each station. Sediments obtained by this method were screened through a 30-mesh-per-inch box screen. Macroinvertebrates retained by screen were hand picked into vials of 95% alcohol and returned to the laboratory for subsequent identification and enumeration.

SIGNIFICANCE OF CHROMIUM

Chromium salts of the hexavalent form (i.e. chromate ions CrO_4^{2-} and dichromate ions $Cr_2O_7^{2-}$) are used in the metal plating process. Of these forms, the sodium, potassium and ammonium chromates and dichromates are soluble in water. Hexavalent chromium can be reduced to the trivalent form (i.e. chromic ions CrO_3 and chromite ions CrO_3^{2-}, CrO_2^{-}) in the presence of organic hatter and reducing agents. The trivalent chloride, nitrate and sulphate salts of chromium are soluble in water. All other chromium salts are insoluble in water and settle as precipitates to the substrate.

The toxicity of chromium salts towards aquatic life varies widely with the species, the valence of chromium, the hardness of the water, the dissolved oxygen concentration and the temperature of the water. Fish are relatively tolerant to chromium salts, but lower trophic levels have been reported to be extremely sensitive to these compounds. All forms of chromium are most toxic in soft water. In general, the trivalent forms are more toxic under aerobic conditions whereas the hexavalent forms are more toxic where anaerobic conditions are present.

Since any number of effects could occur depending upon the factors outlined above, only total chromium concentrations ware measured for both water and mud samples.

Water Chemistry

Chemical analyses of water and mud samples collected at 17 stations on Otter Lake and 4 stations on Oastler Lake are presented in Table 1 of the Appendix. Both lakes contained extremely soft water (range 14 - 20 ppm $CaCO_3$) and were neutral to slightly alkaline, having pH's ranging between 7.1 and 7.3. Low concentrations were obtained for both suspended and dissolved solids.

Chromium in Water samples,

Chromium concentrations present in the surface waters of both Otter Lake and Oastler Lake were extremely low. Trace amounts (0.01 ppm) of total chromium were present at seven of the 21 sampling locations. Chromium was undetectable in the samples from the remaining 14 stations.

Chromium in Bottom muds

Chemical analyses of the bottom sediments at stations 1 to 21 revealed considerably higher levels of chromium. The chromium concentrations in the sediments of Otter Lake ranged between 8.0 ppm at the most distant station from the former effluent discharge to 3470 ppm at station 16, located approximately 100 feet from the former outlet. The range of chromium in the sediments of Oastler Lake varied between 50 and 177 ppm at the four stations examined. These data reflect the accumulation of chromium which occurred in both lakes prior to tile establishment of treatment facilities at Canadian Motor Lamp Company Ltd.

BIOLOGICAL ASSESSMENT OF WATER QUALITY

The distribution and abundance of macroinvertebrates collected from 17 stations on Otter Lake and 4 stations on Oastler Lake is presented in Table 2 of the Appendix.

The macroinvertebrate populations were comprised largely of midge larvae (Chironomidae) and the planktonic phantom midge *Chaoborus,* along with lesser numbers of molluscs, amphipods, mayflies and caddisflies. Both midge larvae and *Chaoborus* were taken consistently in the dredge samples, while the other taxa appeared to be sparsely distributed throughout the lake.

Both species diversity and the relative abundance of organisms was greater in Otter Lake than in Oastler Lake, indicating that Otter Lake has a relatively greater productivity. Chemical analyses of the waters of Otter Lake and Oastler Lake indicated that concentrations of chromium were not present in sufficient quantities to affect the survival of aquatic life. Concentrations of chromium present in the sediments of these lakes, however, could have a detrimental affect on the organic consumers associated with the lake bottoms. Species diversity of macroinvertabrates was greatest at station 7 situated on an elevated plateau in the center of Otter Lake.

Fourteen taxa of macroinvertebrates were obtained from the bottom sediments at that location. Included were the detritus-feeding amphipods *Hyalella azteca*, the siphoning clams Sphaeridae and Unionidae, the burrowing worms Oligochaeta and midges of the family Chironomidae. The concentration of chromium present in the sediments at this station was 158 ppm. Considering the taxa indicated, this concentration appears to be within the safe range for at least short-term benthic habitation but is not known whether there would be long-term effects from continuous association with this concentration. Clams for example, are known to concentrate heavy metals in their body tissue until lethal concentrations are reached.

At stations 16 and 17, adjacent to the metal plating plant, substantial concentrations of precipitate chromium (3,470 and 1,195 ppm, respectively) were detected chemically in the bottom sediments and their toxic effects were indicated by a marked suppression in density of filter-feeding midge larvae. Compared to the average density of 20 midge larvae per station in Otter Lake, only 3 larvae were present at each of stations 16 and 17.

Bottom fauna at the remaining stations appeared to be little affected. The fact that there has been no overall suppression of benthic production is suggested by the lack of marked differences in population structure relative to varying chromium levels in the bottom sediments at different stations.

These data do not clarify the lethal concentration of precipitate chromium for the organisms present in the two lakes, but it would appear to lie somewhere between 158 and 1195 ppm. Since 8 of the 21 sampling locations have concentrations of chromium within this range, further discharges of chromium to the waters of Otter and Oastler Lake could have an adverse effect on the trophic balance of these waters.

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Table 1. Results of chemical analyses of surface water and sediments collected in Otter and Oastler Lake in October. 1966.

Station	WATER					SEDIMENTS	
	Susp. solids	Diss. solids	pH at lab	Hardness	Total chromium	Total chromium	% Organic
1	3	37	7.2	14	0.0	8.0	1.28
2	1	27	7.2	16	0.0	209.0	24.08
3	2	18	7.2	16	0.0	40.6	22.9
4	1	59	7.2	16	0.01	23.0	3.4
5	2	36	7.1	16	0.01	76.0	10.7
6	1	19	7.1	16	0.0	338.0	18.2
7	1	33	7.2	16	0.0	158.0	14.9
8	2	22	7.2	16	0.01	218.0	19.9
9	2	16	7.3	20	0.0	28.0	6.0
10	2	32	7.2	16	0.0	77.0	23.6
11	1	51	7.2	18	0.0	57.0	8.4
12	2	36	7.2	16	0.01	34.0	25.3
13	-	-	-	16	0.0	64.0	7.1
14	3	43	7.2	16	0.0	43.0	11.1
15	1	19	7.2	16	0.01	166.0	8.1
16	2	56	7.1	16	0.01	3470.0	21.0
17	1	23	7.1	18	0.0	1195.0	9.7
18			7.1	16	0.0	60.0	14.5
19	1	23	7.1	18	0.0	177.0	20.7
20	1	41	7.1	16	0.0	50.0	27.6
21	2	38	7.1	16	0.01	58.0	20.4

Table 2. Specimens collected at 21 stations on Otter and Oastler Lake in October, 1966.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
MAYFLIES																					
Caenis	18										1				2						
Hexagenia					1		1		1												
CADDISFLIES																					
Molanna	1								1												
Triaenodes				1			3								1						
Oecatis				2																	
Polycentropus							4	2			2				1						
Phylocentropus								1			1			1		4	1				
FISHFLIES																					
Sialis	3											2	1	1							
LEPIDOPTERA																					
Unidentified							4														
FLIES																					
Chironomidae	3	62	26		17	24	51	28	5	28	8	13	17	19	35	3	3	7	45	5	4
Chaoborus		125	147	3	128	38	10	100	3	50	3	78	52	9	8	73		2	1	13	2
Palpomyia									1				1		7						
AMPHIPODS																					
Hyalella	71	1	1				9				3							5			
MOLLUSCS																					
Unionidae	1						2														
Pisidium	1			1		1	2			2				1	1						
Sphaerium							1														
Helisoma			1																		
Gyraulus							1														
Physa							1														
LEECHES																					
Helobdella			1																		
Glossophoniidae							1														
MITES																					
Unidentified										1					1	2	1				

Table 2. continued

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
COELENTERATES																					
Hydra															1						
WORMS																					
Oligochaeta	1					1	3		1		1						2	3	1	23	1
TAXA	17	4	5	4	3	4	14	4	6	4	8	3	4	5	9	4	3	4	3	3	3
Total Organisms	98	189	175	7	145	54	92	131	12	81	22	93	71	31	54	80	6	17	47	41	7