Natural Hazard Research

WATER QUALITY AND THE HAZARD TO HEALTH: PLACARDING PUBLIC BEACHES

by

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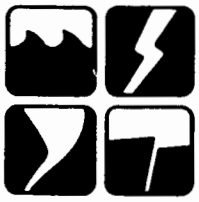
1968



Working Paper #3

PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers will be used as working documents by the group of scholars directly involved in hazard research as well as inform a larger circle of interested persons. The series is now being supported from funds granted by the U.S. National Science Foundation to the University of Chicago and Clark University. Authorship of papers is not necessarily confined to those working at these institutions.

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CHAPTER 1

INTRODUCTION

POLLUTION: A PUBLIC HEALTH HAZARD?

An apparent conflict occurs between the use of water as a medium for sewage disposal, and as a medium for recreation. In theory it is possible to reduce the effects of pollution markedly by the installation of various types of treatment plants. To encourage and try to enforce the introduction of such plants, governments throughout the world have introduced provisions within their jurisdictional frameworks to impose penalties upon polluters.

The Government of Ontario is one such government, having introduced legislation designed to combat water pollution, by providing for the prosecution of suspected polluters, and for the imposition of penalties subsequent to conviction.[1]

A difference exists however between the law as written, and the law as practised, and the release of partly or totally untreated sewage into bodies of open water is

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1. Ontario Water Resources Commission Act, Revised Statutes of Ontario, Chapter 281, (1960).

allowed to continue virtually unabated. The situation in Ontario is further aggravated by the fact too, that unilateral action on the part of the Ontario Government and its agencies is in itself insufficient to ameliorate conditions in many instances, since the most important waters within the Province, namely the Great Lakes, are shared with the United States. As a result, many natural bodies of water in Ontario are polluted to such a level that interference with recreational pursuits occurs, and is likely to continue to occur.

When an area of water is heavily polluted its use for recreational pursuits is diminished on aesthetic grounds and by possible dangers to health. These two features are by no means related in all cases. Water can be aesthetically exceedingly unpleasant yet still be relatively pure from a bacteriological standpoint. The algal growths of the Great Lakes exemplify this in that though they are related to a high level of organic pollution[2] and produce very unpleasant water conditions, they are by no means indicative of pollution, which by any criteria would be considered harmful. Conversely water can be aesthetically pleasing yet contain large numbers of pathogenic bacteria, which under existing standards would

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2. G.B. Langford, The Great Lakes and Their Problems, (Toronto: Great Lakes Institute, 1965), pp. 19-20.

render it to be labelled as a potential danger to health.

In Ontario the recognition of a public health hazard in a stretch of water to which the public has access is the responsibility of medical officers of health. Under the Public Health Act (1966) a medical officer of health is required to:

> "ensure that the municipality or location for which he is appointed is regularly inspected in order to prevent nuisances or to abate existing nuisances."[3]

A nuisance is defined as:

> "Any condition existing in a locality that is or may become injurious or dangerous to health or that prevents or hinders, or may prevent or hinder the suppression of disease."[4]

The normal action taken by medical officers of health under this Act in connection with polluted waters used for recreation is the 'placarding' of public beaches. This process concerns the erection of warning notices indicating in some way that in the opinion of the medical officer of health there are possible risks to health attached to

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3. The Public Health Act, Revised Statutes of Ontario, Chapter 321, s. 86 (1), (1960), p. 45.

4. Ibid., Chapter 321, s. 82, p. 43.

bathing. (Appendix 1.)

A local municipality can reinforce the decision of the medical officer by passing a by-law to prohibit bathing, under provisions contained in Revised Statutes of Ontario (1960) in a section dealing with public health, sanitation and safety.[5] In practice however such a step is not usually taken owing to enforcement difficulties.[6] Thus medical officers of health depend for the most part on co-operation with the public rather than coercion, a situation which presents a variety of responses.

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5. Revised Statutes of Ontario, Vol. 3, Section 379 (1) 62(a), Chapter 249, (1960).
   - General heading:
   (1) By laws may be passed by the councils of local municipalities:
   Health, Sanitation and Safety.
   Bathing 62. For prohibiting or regulating the bathing or washing of the person in any public water in or near the municipality. (R.S.O. 1950, c. 243, s. 388 (1) pars 72-74.)

6. A telephone survey of Metro boroughs revealed that only North York has passed such a by-law. The other four boroughs maintained that the by-law would be unenforceable.

CHAPTER 2

THE DECISION MAKERS AND THEIR CRITERIA

The purpose of this paper is to examine the role and actions of medical officers of health in placarding public beaches and to investigate the literature which forms the basis upon which their decisions are made in this regard. In addition an attempt will be made to analyze whether or not medical officers of health in arriving at their decisions are influenced by anything other than medical considerations.

Medical officers of health are appointed as directors of public health facilities within specified areas. These areas vary in size from townships to large boroughs together with contiguous urban areas. In the case of large health units, provisions are made for the appointment of assistant medical officers of health each having "all the powers" and performing "the same duties as the medical officer of health",[1] and for the appointment, with Department of Health permission, of more than one medical officer of health per unit, each assuming responsibility for

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1. Public Health Act, Revised Statutes of Ontario, Chapter 321, Section 34 (3), (1960).

a smaller area.[2] Provisions are also made for very small areas to combine health facilities under health units, each under one single medical officer of health.[3]

These provisions led in Southern Ontario to a situation whereby until recently medical officers of health were administering areas of widely different types and size. As a result the post of medical officer of health varied in importance, and the individuals holding such posts comprised a diverse group. In some small areas the medical officer of health was combining his duties with general medical practice, whereas in the large boroughs the role played was, and still is, that of chief administrator of a large local authority department. The outcome of this was the existence of a differential ability to deal with all the problems of public health, including that of beach pollution. Therefore some medical officers could not even contemplate action on this subject on their own, whilst others were able to institute regular testing procedures.

Today, as a result of the formation of new Health Units under Section 35 (2) of the Ontario Public Health Act, part-time medical officers have in many instances been displaced, thus this feature of diversity of role and ability to act on a wide range of problems is being eliminated. (Table 1.)

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2. Ibid., Chapter 321, Section 34 (6).
3. Ibid., Chapter 321, Section 35 (2).

TABLE 1

THE RELATIVE SIZES OF HEALTH UNITS USED IN THE QUESTIONNAIRE SURVEY

	Administrative area	Population (1966)	
1.	Victoria and Haliburton	38,685	Recently formed
2.	Muskoka	39,947	
3.	Bruce County	43,085	
4.	Huron County	54,446	
5.	Grey County	62,592	
6.	Norfolk and Haldimand	80,598	Recently formed
7.	Peterborough City and County	81,959	
8.	Northumberland and Durham Counties	89,623	
9.	Ontario County	92,736	
10.	Kent County	94,406	
11.	Lambton County	108,236	
12.	York County	122,401	
13.	Simcoe County	149,132	
14.	Etobicoke	251,953	
15.	Scarborough	278,377	
16.	Metro Windsor - Essex County	280,922	
17.	Niagara District	324,917	Recently formed
18.	Hamilton - Wentworth County	394,299	
19.	Toronto City	664,584	

Source: 1966 Census of Canada, Population. 92-614 May, 1968
92-605 Oct. 1967

The appointment procedure for medical officers varies slightly according to the nature of the administrative area. In the case of municipalities the council has the duty of appointing "a legally qualified medical practitioner to be medical officer of health for the municipality".[4] Continual failure by a municipality to appoint a medical officer of health permits the intervention of the Governor in Council, acting on the advice of the Minister of Health, to make an appointment.[5] For health units the procedure is slightly different, in that appointment and tenure of the medical officer is subject to regulations laid down by the Minister, with the approval of the Lieutenant Governor in Council.[6]

As far as tenure is concerned,

> "every medical officer of health appointed by the council shall hold office during good behaviour and his residence in the municipality, ... and if appointed by the Lieutenant Governor in council shall hold office until the first day of February in the year following that of his appointment. No medical officer can be removed from office except on a two-thirds vote of the

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4. Ibid., Chapter 321, Section 35 (1).
5. Ibid., Chapter 321, Section 34 (2).
6. Ibid., Chapter 321, Section 37 (1).

whole council with the consent and approval of the minister, who may require cause to be shown for the dismissal".[7]

Thus medical officers of health once appointed assume considerable independence, and possess security of tenure comparable to that in any administrative position. Therefore they would appear to be above and beyond the influence of pressure groups present in some areas of resource management.[8] Ostensibly then, any decisions should be made purely on the basis of logical examination of evidence, and information contained in Government directives and in medical literature.

Unfortunately Government information on levels of pollution, and the risk to health of people bathing in polluted water, is very sparse, and the medical evidence scattered.

The Government recommendations on the subject emanate from the Ontario Water Resources Commission. From the outset it ought to be stated that the standard for satisfactory bathing water used in Ontario is one of the least rigorous in North America. From an idealistic point of view both the Ontario Water Resources Commission and the

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7. Ibid.

8. R.E. Kasperson, "Environmental Stress in the Municipal Political System: The Brockton Water Crisis of 1961-6", paper presented in the Water Resources Session, American Association of Geographers Conference, Washington, D.C., 1968.

Provincial Health Authorities express the idea that the standard for bathing beaches should be a logarithmic mean[9] actual or Most Probable Number (M.P.N.) coliform count of less that 1,000 per 100 ml. of water.[10] Taking a realistic point of view however, especially important in view of some of the high counts obtained particularly from Great Lakes beaches, both bodies reluctantly accept that, "up to 2,400 is permissible provided that there is no evidence of increasing pollution, the sanitary survey of the beach area is satisfactory and there is no previous significant epidemiology".[11]

For actual data concerning water pollution within his area of jurisdiction a medical officer of health has three possible sources. The Ontario Water Resources Commission takes routine annual samples in connection with its work of attempting to decrease the general level of pollution of Ontario's water resources, and also undertakes surveys of areas of particular concern. Secondly any member of the public can request that samples be taken. More usually such action is taken by organized pressure groups such as

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9. The Logarithmic mean

$$\text{Log } \bar{X} = \text{Antilog}\left[\frac{\text{Log } X_1 + \text{Log } X_2 \ldots + \text{Log } X_n}{n}\right]$$

10. Actual coliform counts obtained by the membrane filter technique are now more extensively used than the M.P.N.

11. Ontario Department of Health, Division of Environmental Sanitation, Bulletin Number 103: Summer Camps - Sanitation, p. 7.

cottager associations. Finally the Medical Officer himself can request detailed sampling of any water, the quality of which he wishes to ascertain. In all three cases the normal procedure is for the sample to be sent in a sealed container to the Public Health Laboratories of the Provincial Department of Health. The results of laboratory tests are then passed on to the relevant authorities including the Ontario Water Resources Commission and interpretations are made.

The status of medical literature in affecting the decisions of medical officers of health was one of the main aims of the mail questionnaire sent out to selected medical officers of health.

Thus this paper aims to survey the information available to medical officers of health in making the decision as to whether or not effectively to close a beach, and the circumstances of the decision.

CHAPTER 3

MAGNITUDE OF THE RISK

The Provincial Government literature assumes that water with a certain degree of pollution, as measured by the Most Probable Number counts, presents a possible source of infection, thus constituting a public health risk.

Direct empirical evidence on the relationship between bathing in polluted water and illness is not readily available. The reason for this lies in the difficulty of isolating the cause of disease outbreaks generally, and in the fact that in many areas bathing is so common that to indict it as a cause of an outbreak among a limited section of the population presents logical difficulties.

Such evidence as there is on this subject has been collected in three ways. A series of studies have been made which have attempted to assess both in theory and practice the probability of infection arising from bathing in waters of known quality. Other studies have concentrated on the viability of disease organisms in waters of various types, with the aim of establishing that there is a possibility of infection. In addition numerous attempts have been made, with varying degrees of success, to achieve the recognition of positive links

between infectious outbreaks and pollution.

The first category of studies, namely those using a probability-possibility approach, includes two major studies undertaken by the United States Public Health Service and by the Public Health Laboratory of Great Britain respectively, in addition to purely theoretical attempts to calculate the risk of infection from bathing in polluted water.

The United States Public Health Service study was by far the most comprehensive survey devoted to assessing the affects of bathing in polluted water so far attempted. Three different sites were chosen for intensive investigation, namely a beach area near Chicago on Lake Michigan, a site on the River Ohio and a nearby circulating swimming pool at Dayton (Ky.), and two beaches on Long Island at New Rochelle and Mamaroneck. Each location had over 1,500 families in the vicinity, with both bathers and non-bathers, the latter acting as control groups. In addition all three areas showed little seasonal bacteriological fluctuation, an important factor in view of the method of analysis, which involved comparing results gathered over the whole summer. Detailed checks were made in all instances to record all illnesses in the chosen communities and data giving the number of illnesses per thousand of both the bathing and non-bathing populations were calculated. No overall

significant correlation was observed between bathing in dubious waters and illness rates, but at South Beach, Chicago, and in the River Ohio, high pollution levels, of 2,300 and 2,700 M.P.N. coliforms per 100 ml. of water, and an increase in illness were positively correlated at an .01 level of significance. Generally however the only conclusion that can be arrived at from the study is that there is seemingly little connection between swimming in polluted water and the contraction or spread of disease.[1]

The report of the Committee on Bathing Beach Contamination of the Public Health Laboratory Service of Great Britain, conducted under the chairmanship and influence of Dr. B. Moore, was less rigorous in its approach especially with regard to the collection of medical evidence, since only serious illnesses such as typhoid, paratyphoid, and poliomyelitis, in other words notifiable diseases, were considered. On the other hand however a large number of sites were included in the survey, thus enabling general conclusions to be made on the level of pollution at which a serious risk to health is incurred by bathers. The evidence gathered by the committee revealed four cases of paratyphoid in the period 1956-58, where the putative

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1. A.H. Stevenson, "Studies of Bathing Water Quality", American Journal of Public Health, XLIII (1953), 529-538.

cause was bathing in polluted sea water. Only two beach areas were implicated and both had M.P.N. coliform counts of 10,000 or more, and were described as aesthetically very unsatisfactory. A controlled study was in addition carried out to investigate the possible connection between poliomyelitis and bathing water quality, and the general conclusion was that on the basis of the evidence available no statistical relationship existed.[2]

An entirely statistical approach to assessing the probabilistic relationship between pollution and infection risk was used by the Ohio River Valley Commission. Their study used morbidity-mortality ratios for typhoid in the seven valley states and assumed a 1:1700 chance of ingesting E. typhosa based on calculations by Kehr and Butterfield,[3] assuming a M.P.N. coliform count of 1,000 per 100 ml. of water. This gave a 1:19 risk for each swimmer of coming into contact with E. typhosa in a full 90 day season, assuming daily bathing. Again using Kehr and Butterfield's calculations of a 2 per cent chance that persons being exposed to E. typhosa would contract the disease, they

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2. Committee on Bathing Beach Contamination of the Public Health Laboratory Service, "Sewage Contamination of Coastal Bathing Water in England and Wales: A Bacteriological and Epidemiological Study", Journal of Hygiene, LVII (1959), 435-473.

3. R.W. Kehr and C.T. Butterfield, "Notes on the Relation Between Coliforms and Enteric Pathogens", Public Health Reports, LVIII (April 9th, 1943), 589-607.

arrived at the conclusion that there was a 1:950 probability in a ninety-day season that the disease would be contracted. From these figures using the relationship in the seven states between morbidity and mortality rates for typhoid and enteric diseases, the probability of contracting the latter was calculated in 1945-47 to be 22:1, assuming daily immersion.[4]

Attempts at tracing disease epidemics and outbreaks to their sources also provide some estimation, albeit extremely conservative, of the risk to health from bathing in polluted water.

The most common of the serious diseases attributed to bathing in polluted water are typhoid and paratyphoid. Several well documented cases exist including those revealed by the Committee of the Public Health Laboratory Service cited above. Two additional sets of outbreaks are discussed in the report by this body. The first was an outbreak which occurred at the Royal Marine Depot in Walmer, Kent, England in 1909, when numerous cases were traced to the swimming pool and thence to a local sanitarium, the outfall sewer of which discharged only 100 yards from the pool intake. The second set of outbreaks occurred in New Haven and New York in 1921-2 and 1932 respectively.

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4. "Bacterial Quality Objectives for the Ohio River", Public Works, LXXXIII, 1 (1952), 53-55.

Neither city at the time had primary sewage plants and therefore the waters in the vicinity of them were polluted to such a degree that bathing was restricted on aesthetic grounds, and would under any known standard used today be considered very unsafe.[5]

A more recent case from Perth, Australia indicates that an outbreak of typhoid in 1958 could have been due to, or increased by, bathing. Five out of eight early sufferers had bathed at the same beach, namely City Beach, and five out of seven subsequent sufferers bathed at the beach prior to its closure. The presence of five phage types automatically eliminated one source of food as the possible cause, and thus strong suspicion was thrown onto the inadequate means of sewage disposal, namely a mile-long sewage outlet discharging into the Indian Ocean, which upon inspection was revealed to have several breaks along its length. Wind action, self-purification tendencies of sea water, dilution, aeration, salinity, sunlight and the presence of predatory bacteria were all held responsible for restricting the effects of the epidemic, otherwise the question might have been posed as to why more people

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5. B. Moore, "Some Bacteriological Aspects of Sewage Pollution of Bathing Beaches", Royal Society for the Promotion of Health Journal, LXXIX, 6 (1959), 730-734.

failed to contract the disease.[6]

A similar outbreak of typhoid was reported in 1961 from Poland. Previous studies on beaches in Poland had failed to show any connection between contamination, as revealed by the presence of coliforms, and salmonellae.[7] In 1959 however four sporadic cases of typhoid occurred at Orlow. One case was traced to a carrier, but the source of the other three could not be ascertained. Of the three however, one was said to have bathed frequently in water in which salmonellae were identified, and the other two were visitors to the town, who "could have been affected while bathing". The report of the occurrence apparently was lacking in certain essential critical information and therefore must be treated with some caution.[8]

In addition to the above quoted cases of typhoid a number of cases of paratyphoid have also been associated with bathing in polluted water, but they are not sufficiently deserving of merit to warrant individual treatment in any of the more generally obtainable literature.

Nine cases of pulmonary tuberculosis, associated with immersion in sewage, have been reported from the United

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6. "Typhoid Traced to Bathing at a Polluted Beach", Public Works, XCII, 5 (1961), 182 and 184.

7. Z. Buczowska, "Research in the Bacterial Pollution of Coastal Waters", Bulletin of Hygiene, XXXV (1960), 426.

8. Z. Buczowska and B. Nowicka, "Locating Salmonella Infection Sources of River and Bathing Beach by Means of Sewage Examination", Bulletin of Hygiene, XXXVI, 9 (1961), 853.

States of America, the United Kingdom, and Germany.[9] In all cases however the infection was associated with near drowning and the only really useful conclusion that can be drawn is that ingestion of substantial amounts of raw sewage, prior to full dilution in a large mass of water, provides a substantial risk of infection by tubercle bacilli.[10]

In the case of the remaining serious diseases capable of a separate existence in water, and thus transmissible through water, there seems to be little likelihood that infection has ever occurred directly as a result of bathing. Poliomyelitis was at one time thought to be transmissible through bathing in infected water. The basis for suspicion lay in the fact that poliovirus has been identified at moderately large distances from sewage outfalls,[11] and in some instances, such as in Edmonton, Alberta in 1953, circumstantial evidence led to hasty conclusions being made.[12] The Federal Department of Health as of August, 1959, is

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9. P.W. Kabler, H.F. Clark and N.A. Clarke, "Pathogenic Micro-organisms and Water Borne Disease", Proceedings of the Rudolfs Research Conference, Rutgers, The State University, New Brunswick, New Jersey (June 1961), pp.9-57.

10. F.J.W. Miller and J.P. Anderson, "Two Cases of Primary Tuberculosis after Immersion in Sewage-Contaminated Water", Archives of Diseases in Childhood, XXIX (1954), 152-154.

11. D.M. McLean, "Contamination of Water by Viruses", American Water Works Association Journal, LVI (1964), 585-591.

12. N.A. Clarke and S.L. Chang, "Enteric Viruses in Water", American Water Works Association Journal, LI, 2 (1959), 1299-1314.

officially on record as stating that no proven connection exists between poliomyelitis and bathing in polluted water.[13] This point is tentatively supported by Brown,[14] Clarke and Chang,[15] Laubusch,[16] and Lehr and Johnson,[17] all of whom could find no satisfactorily documented case to prove an association. Thompson,[18] in his investigation of a poliomyelitis epidemic in Auckland, New Zealand in 1950, examined the bathing histories of the 345 sufferers, and those of others bathing at the suspect beach at the same time, and arrived at the conclusion from his investigations that there was in fact a negative correlation between bathing and infection.

Some authorities maintain that hepatitis can be spread through bathing in polluted water. Certainly epidemic

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13. Globe and Mail, (Toronto, August 29, 1959).
14. J.R. Brown, "Public Health Hazards of Bathing", unpublished M.D. thesis, University of Toronto, 1966, 153p.
15. N.A. Clarke and S.L. Chang, op. cit.
16. E.J. Laubusch, "Rationale and Accomplishments of Chlorine Disinfection", Proceedings of the Rudolfs Research Conference, Rutgers, The State University, New Brunswick, New Jersey (June, 1961), pp. 543-611.
17. E.L. Lehr and C.C. Johnson, "Water Quality of Swimming Places: A Review", Public Health Reports, LXIX (1954), 742-747.
18. Committee of the Public Health Laboratory Service, op. cit.

outbreaks of the disease have been traced to polluted waters, but apparently in all cases, infection occurred through use of the waters for consumptive purposes rather than for bathing. Thus Mosley[19] reports that no cases of infectious hepatitis are attributable to swimming or even accidental immersion in sewage, although Clarke and Chang[20] claim a total of seventeen waterborne epidemics.

Thus the risk of contracting a serious disease through bathing in possibly polluted water as judged by epidemiological evidence, appears to be infinitessimally small, if not virtually non-existent.

The epidemiological approach for studying the possibility of minor infections being contracted is not as conclusive even as for major maladies. This is due to the fact that most of the minor illnesses which could be due to bathing in polluted water are so minor as not even to warrant medical attention in many cases. Even when this is not the case they are not notifiable, and therefore public health authorities have no method of recording them systematically.

In all the literature it is recognized that water is an unnatural habitat for man and that therefore minor disorders are to be expected from bathing wherever it is indulged in.

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19. Referred to in P.W. Kabler, H.F. Clark and N.A. Clarke, op. cit.

20. N.A. Clarke and S.L. Chang, op. cit.

Eye ailments such as conjunctivitis, ear, nasal and sinus infections occur frequently even from swimming in chlorinated circulating pools. This point is borne out by the observations made at Dayton, Kentucky by the Committee on Bathing Places, which found that there was a greater number of illnesses derived from the swimming pool than from the river, but that most of the swimming pool illnesses were associated with ear, nose and throat and were thought to be the result of diving, or infections spread by contact.[21]

Gastro-intestinal ailments were also found by the survey to be common amongst bathers in all types of water. Dysentery and diarrhea, frequently confused in diagnosis, are not notifiable diseases. In fact the latter may not even be reported to a member of the medical profession, thus records concerning the disease, and its relationship to bathing, particularly in polluted water, are far from complete. Only extensive outbreaks such as that reported in McKee and Wolf,[22] of 144 severe cases of dysentery which occurred in Indiana apparently in connection with septic tank effluent, ever receive attention. On the basis of the incomplete evidence available the general opinion

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21. Joint Committee on Bathing Places, "Progress Report on the Engineering Section of the United States Public Health Service with the Conference of Sanitary Engineers", American Journal of Public Health, XLII (1952), 93-103.

22. J.E. McKee and H.W. Wolf, Water Quality Criteria, 2nd edition, The Resources Agency of California, State Water Control Board (Los Angeles, 1963).

seems to be that such diseases can be water borne, but there is a lack of commitment to the idea that they are especially common in connection with polluted, as opposed to relatively pure, water.

Schistosomiasis, otherwise known as swimmers itch, is without question a disease transferable via water. It is associated with a snail host which lives in brackish or fresh water, and can be troublesome and cause epidemics, but no definite connection exists between the presence of the disease organism, or the snail host, and pollution. Therefore although detection would warrant placarding of an area, this disease has little relevance to the question as to whether there is a public health risk attached to bathing in waters of particular qualities.[23]

Leptospirosis, a disease relatively common in domestic and wild animals, has also been identified in the United States by Galton[24] as being spread by swimming and wading in ponds and slow moving creeks polluted by animal excreta. The greatest danger occurs in late summer, and young adults appear to be particularly susceptible.

In addition to the diseases and ailments discussed above there are minor conditions associated with the infection of wounds and subsequent granulatomous lesions.[25] None of

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23. E.J. Laubusch, op. cit.
24. P.W. Kabler, H.F. Clark and N.A. Clarke, op. cit.
25. J.E. McKee and H.W. Wolf, op. cit.

the works examined however concentrate on this point since this type of illness can obviously be obtained in a variety of ways, and through a variety of media, the use of which is not questioned on health grounds.

The third approach for trying to assess the probability of infection occurring through bathing in polluted water lies in assessing the viability of the various organisms in such media.

Forty to ninety per cent of sewage bacteria according to Kabler et al. die within a few hours of contact with sea water.[26] Experiments have revealed that the remaining bacteria can however survive for long periods. Thus S. typhosa was reported by Kraus and Weber to have survived up to twenty-six days and S. schottmuelleri seventy days.[27] Experiments conducted from Marseille by Nicati and Rietch on Vibio comma, the bacteria responsible for cholera, revealed survival rates ranging from thirty-two to eighty-one days, the highest figures being obtained in the vicinity of Marseille harbour, where the level of general pollution was highest.[28]

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26. P.W. Kabler, H.F. Clark and N.A. Clarke, op. cit.
27. Ibid.
28. G.T. Orlob, "Stream Pollution: Viability of Sewage Bacteria in Sea Water", Sewage and Industrial Wastes, XXVIII, 2 (1956), 1147-1167.

As a general rule however human enteric pathogens do not survive for extended periods outside the body of the host.[29] Therefore in order for infection to occur, the discharge point for the sewage and the bathing area must be located very close together.

It must be added at this point however that the relationship between disease survival rates and pollution is by no means established as direct, and could in fact be inverse.[30]

Thus on the evidence so far made available, there would appear to be only a very weak correlation between bathing and danger to health, and even weaker evidence that bathing in polluted water is more likely to cause illness than bathing in water allegedly bacteriologically pure, except in circumstances which are obviously epidemiologically hazardous. Statements such as those of the Conservation Council of Ontario, that, "all wastes of sewage origin be recognized as potentially a source of disease, regardless of the absence of a traceable outbreak ..."[31] would thus seem to be erring on the side of extreme caution. This caution it would appear is shared by those responsible for setting up the arbitrary limits for water quality, which attempt to define levels at which there is a possible danger to public health.

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29. E.J. Laubusch, op. cit. and G.T. Orlob, op. cit.

30. P.W. Kabler, H.F. Clark and N.A. Clarke, op. cit.

31. Conservation Council of Ontario, Water Pollution in Ontario: Report. (Toronto, September, 1964).

CHAPTER 4

THE RELIABILITY OF THE INDICATORS

Determination of the suitability or otherwise of a body of water for bathing or other recreational pursuits can be achieved in several ways.

The most commonly used basic criteria approved by the United States Public Health Service, involve assessment of the Most Probable Number (M.P.N.) or the actual number of coliforms contained in a given amount of sample water. Some workers, particularly Europeans, have attempted to go further than this and assess the Most Probable Number of the main species found in water, namely Escherichia coli, on the grounds that these represent more truly the presence of fecal material from warm blooded creatures, and ipso facto, the possible presence of pathogenic bacteria.[1] Others have rejected all classifications based on the coliform group, or rejected them for some purposes, preferring instead use of the enterococci group as an indicator.

Usual practice in Ontario and elsewhere involves

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1. H.F. Clark and P.F. Kabler, "Re-evaluation of the Significance of the Coliform Bacteria", American Water Works Association Journal, LVI (1964), 931-936.

additional dependence upon good sanitary surveys. These involve analysis of the relative locations of beach and recreational areas to sources of potentially dangerous pollutants, particularly untreated or only partially treated human excrement. In addition attention can be given to aesthetic considerations, although normal practice is to leave this to the discretion of the individual.

The Coliform as an indicator of pollution

Coliforms were first identified and described by Escherich in 1885 as a bacterial species considered to be characteristic of human feces. By 1895 this relationship had been extended by T. Smith who stated that coliforms represented a statement of fecal pollution, and thus a danger to health wherever found.[2]

By 1902, the presence of B. coli in association with certain harmful bacteria was established by the Lawrence Experiment Station, Lawrence, Massachusetts. They discovered that B. coli were to be found in dilutions in excess of 1:50,000, at which point sewage streptococci were not identifiable. Furthermore, satisfactory correlations were established between the viability of B. typhosus and B. coli, under a variety of conditions including exposure to

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2. H.F. Clark and P.F. Kabler, ibid.

sunlight.[3]

The extensive use of B. coli as an indicator organism ensued, although initially only for potentially potable supplies. Winslow and Moxon in 1928 extended the use of coliforms to bathing beach criteria, defining a safe bathing beach as one where the water contained less than 10 indicated coliforms per millilitre.[4] In 1940, the Joint Committee of the United States Public Health Service and the Conference of State Sanitary Engineers recommended that a reasonable standard of safety was provided, when "not more than 15 per cent of the sample shall contain more than 200 bacteria per millilitre of water, (2,000 per 100 millilitres), or show a positive test in any 5 or 10 millilitre portions at a time when the waters are in use".[5,6] They also recommended that State Health Departments should undertake surveys with a view to demarcating the most polluted beaches, and analyzing the effects of various changing factors on the degree of pollution.[7]

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3. J.A. McCarthy, "Critical Evaluation of Coliform Organisms", Proceedings of the Rudolfs Research Conference, Rutgers, The State University, New Brunswick, New Jersey (June, 1961), pp. 123-166.
4. J.R. Brown, "Bacteriological Standards for Bathing Water", Medical Services Journal of Canada, XXI, 11 (1965), 778-786.
5. A.E. Berry and A.V. Delaporte,"Standards and Regulations for Quality of Water in Bathing Places", Canadian Municipal Utilities (Formerly Canadian Engineering), LXXVIII, 8 (1940), 5-8 and 11-12.
6. Committee of the Public Health Laboratory Service, op. cit.
7. Ibid.

In 1948, the same committee produced another report which came to peculiar contradictory conclusions. Thus it ran:

> "It is emphasized that the final classification of bathing water should depend largely upon sanitary survey information",

but later went on to state that:

> "water showing a concentration of Most Probable Number of coliform organisms of less than 1,000 per 100 millitres are considered in most cases to be fairly acceptable for bathing unless the sanitary survey discloses immediate dangers from human sewage pollution".

In addition the report whilst refusing to recommend a nationwide standard for bathing quality listed as one of the subsidiary aims of its planned experiments to establish an epidemiological basis for future work, and "the development of a sound bathing water standard".[8]

Early standards using coliform counts were based on the Phelps Index as developed by the Michigan Stream Commission.[9] (Table 2). This Index was used until 1936, when the Most

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8. A.H. Stevenson, "Water Quality Requirements for Recreational Uses", Sewage Works Journal, XXI (1949), 110-114.

9. C.R. Cox, "Acceptable Standards for Natural Waters Used for Bathing", Proceedings of the American Society of Civil Engineers, Separate Number 74, LXXVII, 1 (1951), 1-7.

TABLE 2

THE PHELPS INDEX OF THE MICHIGAN STREAM COMMISSION

10 - 100	Good water. Normal for the Great Lakes. Sewage pollution free.
100 - 1,000	Normal for inland streams. Free of harmful sewage.
1,000 - 10,000	Suspicious. Mild risk in normal waters but dangerous near sewage outfalls.
10,000 - 100,000	Menace to health.
Over 100,000	Heavy sewage pollution. Definitely dangerous.

Source: Cox, C.R. "Acceptable standards for natural waters used for bathing", Proceedings of the American Society of Civil Engineers, Separate Number 74, LXXVII, 6 (1951), pp. 1-7.

Probable Number replaced it.[10] The relationship between the two measures apparently accounts for the choice of many authorities of a Most Probable Number count of 2,400 per 100 millilitres as an arbitrary outside measure of acceptability for bathing water, since this corresponds to 1,000 per 100 millilitres on the Phelps Index,[11] and this level was identified by the Michigan Stream Commission as being that at which suspicion was aroused, and would denote potential danger if in the same area as sewage outlets.[12]

The Most Probable Number method of testing samples, which was used extensively by the Ontario Water Resources Commission and by the Provincial Health Laboratories until recently, has been severely criticized on account of its relative crudity. It involves the use of "a minimum series of three, but preferably five lactose broth or lauryl tryptose broth tubes inoculated with decimal quantities"[13] of the sample water. These fermentation tubes are then incubated at 35° ± 0.5° C. for 48 ± 3 hours, and examined for the presence of gas formation. Interpretation of the testing procedure is then done by selecting the highest dilution giving positive results and the two next higher dilutions and comparing them with results in tables which

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10. J.E. McKee and H.W. Wolf, op. cit.
11. A.H. Stevenson, op. cit. (1949).
12. C.R. Cox, op. cit.
13. American Public Health Association et al., Standard Methods for the Examination of Water, Sewage and Industrial Waste. (New York: American Public Health Association Inc., 1955), p.596.

yield the Most Probable Number equivalent calculated on a probabilistic basis.[14] The membrane filter technique of analysis, which has replaced the Most Probable Number technique in Ontario, involves direct count procedures and thus overcomes many of the objections to the latter method.

The use of rigid coliform count criteria has been criticized on a number of grounds ranging from a questioning of their validity as indicator organisms to attacks on the Most Probable Number Method.

As demonstrated previously such evidence as there is to connect pollution and bathing risk indicates that there is a greater possibility of contracting minor diseases of the ear, nose, throat and eyes, than of contracting gastro-intestinal illnesses. It is however the latter alone which are tested by the coliform. Thus coliforms act only as indicators of intestinal bacteria. Smith and Woolsey's figures and those of the United States Public Health Service demonstrate only too clearly that coliform criteria may therefore identify as few as just 10 to 20 per cent of the possibly harmful bacteria.[15]

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14. Ibid., p. 604.

15. R.S. Smith, T.D. Woolsey and A.H. Stevenson, A Study of Bathing Water Quality on the Chicago Lake Front and its Relation to Health of Bathers, (Cincinnati, Ohio: Environmental Health Center, 1951).
Number in sample - 2,130.
Gastro intestinal illnesses - 10 per cent.
Skin infections - 13 per cent.
Eyes, ears, nose and throat infections. - 77 per cent.

In connection with successfully identifying possible disease organisms in water the coliform test seems to have been proved unsuccessful by Gallagher and Spino, who taking evidence from rivers in Minnesota, North Dakota, Georgia, Washington and Nevada, concluded that there was no significant relationship between Most Probable Number levels of 1,000 and 2,400, and the identification of salmonella bacteria.[16]

The problem of coliform survival rates, with relation to varying environmental factors, has also given rise to criticism of the general use of coliforms. Actual coliform Most Probable Numbers are held to vary according to sampling position, tidal conditions, wind force, temperature, rainfall,[17] season,[18] bathing load,[19] the physical nature of the water from which the sample was taken,[20] the lag between

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16. T.P. Gallagher and D.F. Spino, "The Significance of Numbers of Coliform Bacteria as an Indicator of Enteric Pathogens", Water Research, II (1968), 169-175.

17. Committee of the Public Health Laboratory Service, op. cit.

18. F.W. Gilcreas and S.M. Kelly, "Relation of Coliform Organism Test to Enteric Virus Pollution", American Water Works Association Journal, XLVII, 2 (1955), 683-694.

19. J.E. McKee and H.W. Wolf, op. cit.
The viability of B. coli is decreased by profuse plankton. The number of E. coli in foams is increased by 100 to 1,000 times the number present in the body of water.

20. R.M. Scott, V.L. Walker and E.S. Clark, "Bacteriological Studies in Swimming Pool Waters", Journal of Bacteriology, LXVII (1944), 445-446.
Overnight samples of water have shown a tendency to display decreases or the elimination of pollution bacteria compared to samples processed immediately.

sampling and laboratory testing,[21] and the culture medium used in the laboratory testing process.[22] If this state of affairs is the case then standardization is lacking in all respects, and "each agency may be talking a different language which is unintelligible to the others".[23]

The relative survival rates of disease organisms and coliforms, in other words the validity of one of the most important criteria for the selection of coliforms as indicators, is also questioned. On this point there seems to be general agreement in the literature. Garber, citing Nusbaum and Garver, maintains that coliforms are more viable than pathogens in certain conditions,[24] and are capable, if given the correct environment of increasing in number.[25]

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21. L.A. Kay, "The Construction and Operation of Open Air Swimming Pools", Canadian Journal of Public Health, LVII (1960), 411-414.

22. W.F. Garber, "Critical Evaluation of Objectives and Standards of Bathing Water Bacteriological Quality," Proceedings of the Rudolfs Research Conference, Rutgers, The State University, New Brunswick, New Jersey, (June, 1961), pp. 463-521.

23. H. Romer, "Stream Pollution: The Health Department's Role in New York Harbour Pollution Control", Sewage and Industrial Wastes, XXVIII, 2 (1956), 1495-1503.

24. W.F. Garber, "Bacterial Standards for Bathing Waters", Sewage and Industrial Wastes, XXVIII, 1 (1956), 795-808.

25. W.F. Garber, op. cit. (1956 and 1961).
Regrowth of coliforms has been observed to take place in cellulose pulp sugars.

Thus old sewage can yield higher counts than recently discharged material. This viewpoint is supported by Kabler et al. who summarize the whole situation by stating that the presence of coliforms does not preclude the total absence of viruses and fecal infection.[26]

Mallman in his work spread over a time span of over thirty years, during which he was constantly advocating the use of the fecal cocci group instead of the coli group, raises all types of objections to coliforms backed by experimental data. He quotes the case of the lake near his summer home with "no possible source of contamination" used by very few people, which has a Most Probable Number coliform count of 2,000 per 100 millilitres or more depending on the weather and season, but which never produced a fecal cocci count.[27] He also gives the results of experiments carried out in Los Angeles, in a desert area with again no obvious source of fecal contamination, and where even so coliform and E. coli counts were obtainable.[28] (Table 3.)

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26. P.W. Kabler, H.F. Clark and N.A. Clarke, "Pathogenic Microorganisms and Water Borne Disease", Proceedings of the Rudolfs Research Conference, Rutgers, The State University, New Brunswick, New Jersey (June, 1961), 9 - 57.

27. W.L. Mallman, "Streptococcus as an Indicator of Swimming Pool Pollution", American Journal of Public Health, XVIII, 1 (1928), 771-776.

28. W.L. Mallman, "Water Quality Yardsticks", American Water Works Association Journal, XLV, 8 (1953), 917-926.

TABLE 3

EXPERIMENTAL DATA REVEALING THE PRESENCE OF COLIFORMS AND E.COLI IN STREAM WATER IN A DESERT AREA

Sampling Point	M.P.N.	E. coli
Inlet, Haiwee	86.0	15.3
Outlet, Haiwee	9.2	4.7
Inlet, Fairmont	19.5	8.8
Outlet, Fairmont	23.5	13.7
Inlet, Dry Cañon	26.5	16.7
Outlet, Dry Cañon	31.9	17.2
Outlet, Upper San Fernando	47.9	28.6
Outlet, Lower San Fernando	26.3	26.5
Outlet, Stoney Cañon	7.3	7.3
Outlet, Hollywood	7.6	7.6

Source: Mallman, W.L. "Water Quality Yardsticks", American Water Works Association Journal, XLV, 2 (1953), 920.

Both these statements tend to reinforce the cautionary statement given above concerning the interpretation of results.

The inaccuracy of coliform tests and the wide variation of standards used for them provide further grounds for opposition to their use as an indication of fecal pollution and possible bathing risk.

The 95 per cent confidence limit of one coliform test using three tubes in each dilution is equivalent to 3.6 times the Most Probable Number. Thus if the Most Probable Number is 2,400 then the 95 per cent confidence limit of its accuracy is defined by the figure 8,640.[29] In addition errors can be introduced in the sampling process which will raise or lower this figure by an additional 20 per cent in homogeneous water and by even more in non-homogeneous.

The lack of agreement on standards within which to fit coliform data represents if anything a greater problem than any mentioned above, since it admits that even if technical considerations were satisfied the administrational would not be. Garber displays the present chaos by listing the various standards used in the United States and Canada. They consist of a bewildering range of Most Probable Number criteria. Not only are different figures quoted, but also calculations are done in a variety of ways. Thus authorities

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29. "Typhoid Traced to Bathing at a Polluted Beach", op. cit.

are using percentages of samples beyond certain levels, arithmetic means, geometric means, medians, quadratic means, and harmonic means. Again Garber has provided some insight into the confusion by employing the same set of statistics, for Santa Monica Bay, California in several different ways.[30] The resulting discrepancies demonstrate only too clearly that actual standards used in the United States and Canada have little connection, one with another, and therefore the basis for their very existence is suspect. (Table 4)

Thus the coliform test designed as it was for potable water supplies is particularly suspect when used to assess the quality of pure streams, sluggish warm streams, shallow lakes with high biological activity, shallow wells, swimming pools,[31] and sea water.[32] In other words its usefulness is strictly limited.

Escherichia coli. as indicators

The coliform group contrary to the opinions of early investigators does not solely represent fecal pollution, there being two entirely different main species, one E. coli, being derived from the intestinal tract of warm blooded animals and the other Aerobacter aerogenes, being derived

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30. W.F. Garber, op. cit. (1956).

31. W.L. Mallman, op. cit. (1928).

32. B. Moore, "Sewage Contamination of Coastal Bathing Waters", Bulletin of Hygiene, XXIX, 7 (1954), 71.

TABLE 4

COMPARISON OF VARIOUS COLIFORM STANDARDS USED IN THE UNITED STATES AND CANADA*

Type of Index	Approximate equivalent protection
% greater than 10/ml.	20% greater than 10/ml.
% greater than 1/ml.	60% greater than 1/ml.
Geometric mean	Means greater than 2.5/ml.
Arithmetic mean	Means greater than 9.5/ml.
Median	Medians greater than 2/ml.
Graphic solution	Graphic means greater than 2.5/ml.

* From data for Santa Monica Bay, California.

Source: W.F. Garber, "Stream Pollution: Bacteriological Standards for Bathing Waters", (Table 1), Sewage and Industrial Wastes. XXVIII, 1 (1956), 797.

from plants.[33] In 1904, a test was devised by C. Eykman, which purported to provide a means of distinguishing, to a limited degree, between the two species. Thus in certain parts of the world, Europe in particular, distinction is made between the two types. In North America however there has been a tendency to concentrate on testing water for the whole group only.[34] Standard Methods for the Examination of Water, Sewage and Industrial Wastes has in fact never attempted to include the distinction in its definitions of criteria, primarily on the grounds that the testing procedure is not certain enough to warrant their approval.[35]

Tests for E. coli, where carried out, have most of the faults of the general coliform test and escape only from the type of criticism that Mallman levels against the latter, concerning the presence of coliforms even when no evidence of sources of pollution is available.[36] They therefore present only marginal advantages and the reluctance to adopt them extensively, from the point of view of bathing water quality criteria, is not of very great significance.

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33. J.E. McKee and H.W. Wolf, op. cit.

34. H.F. Clark and P.F. Kabler, op. cit.

35. J.A. McCarthy, op. cit.

36. W.L. Mallman, op. cit. (1953).
W.L. Mallman, op. cit. (1961).
W.L. Mallman and A. Sypien, "Pollution Indices of Natural Bathing Places", American Journal of Public Health, XXIV, 2 (1934), 681-688.

Enterococci as indicators

The use of enterococci as indicator organisms has only recently been again widely advocated. Between 1894 and 1900 they were held in quite high regard, but comparative tests with coliforms, which showed that they had a faster die-off rate in sewage-contaminated water than coliforms, led to the latter becoming very much more popular.[37]

Today it is admitted that the advantages of coliforms are not present under all conditions and that therefore a very good case can now be made for the use of enterococci. The change in attitude towards enterococci which has occurred is in no small way due to the activities of a small number of workers, of whom W.L. Mallman is foremost.

The requirements of good indicators, according to McCarthy, are that they be present in human and animal excreta even after treatment, that they should outnumber the pathogens which they are being used to indicate, and that they should be capable of being expressed in terms of a numerical scale.[38] In the past one of the great criticisms of enterococci lay in the fact that they did not outnumber pathogens to the significant extent that coliforms did.[39]

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37. W.L. Mallman, op. cit. (1928).
38. J.A. McCarthy, op. cit.
39. W.L. Mallman, op. cit. (1928).

Improved media used in the testing process have however decreased the importance of this objection.[40] As far as other criteria are concerned enterococci appear to be adequate. In addition they have certain advantages over coliforms.

The most important advantages lie in the fact that irrespective of classification they demonstrate the presence of sewage contaminants.[41] The lower count number than coliforms, a feature which at one time was held to be a great disadvantage, is today regarded as nowhere near so significant. The reason for this lies in the fact that enterococci, unlike coliforms, do not appear to have a long survival time outside the body of the warm blooded creature from which they come.[42] This means that their presence is an indication of recent fecal pollution[43] and therefore more significant from a health point of view.

In addition enterococci provide indication of bacteria other than those of intestinal origin. This is especially relevant when the available epidemiological evidence, which

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40. W.L. Mallman, op. cit. (1961).

41. W.L. Mallman, op. cit. (1928).

42. Z. Buczowska, B. Nowicka and Z. Kubanek, "Evaluation of Enterococci as Indicators of Coastal Water Pollution", Bulletin of Hygiene, XXXVII, 6 (June, 1962), 548.

43. W.E. Littanzi and E.W. Mood, "A Comparison of Enterococci and E. coli as Indices of Water Pollution", Sewage and Industrial Wastes, XXIII (1951), 1154-1160.

reveals the importance of diseases of the eyes, ears, nose and throat, is taken into account.[44]

On the debit side enterococci provide many of the same problems as coliforms. They are only an indication, not a statement, of fecal pollution of a potentially harmful nature. They are subject to the same errors of sampling and testing and there is some doubt owing to a lack of empirical data as to how results should be interpreted. There seems however to be a certain amount of agreement on the fact that in some circumstances they provide a better indicator of the types of bacteria which it is thought or known cause some illness from bathing.

Sanitary surveys

The sanitary survey approach to assessing the suitability or otherwise of beaches for bathing is much used, simply because it provides a relatively easy way of stating that a potential risk to public health exists, and of conveying information of this risk to the public, an important factor as far as medical officers of health are concerned.

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44. a) A.H. Stevenson, op. cit.
b) R.S. Smith and T.D. Woolsey, op. cit.
c) R.S. Smith, T.D. Woolsey and A.H. Stevenson, A Study of Bathing Water Quality on the Chicago Lake Front and its Relation to the Health of Bathers (Cincinnati, Ohio: Environmental Health Center, 1951).
d) A.H. Stevenson and T.D. Woolsey, "A Statistical Study of Illness in Relation to Natural Bathing Water Quality", paper presented to the 77th Annual Meeting of the American Public Health Association, Oct. 27th, 1949.

Normally the sanitary survey is used in association with other methods of defining pollution. The public health authorities of Connecticut for instance combine their sanitary surveys with coliform counts to produce a shoreline classification, which is constantly modified in the light of improvements to the sewage systems.[45] In Ontario no such rigid use is made of sanitary surveys, but the Ontario Water Resources Commission, which is the body responsible for the Ontario Provincial Health Authority's standards, uses them in their attempts to reduce pollution in the Province and many medical officers of health follow the Commission's lead.

The effectiveness of using sanitary surveys is difficult to assess since they are subjective by nature, but it seems to be the case, from the limited available evidence, that disease outbreaks of a serious nature are associated with highly polluted waters into which sewage outfalls discharge.[46]

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45. a) L.K. Sherman, "Connecticut Studies its Shore Bathing", Bulletin of Hygiene, XXXVII, 4 (1962), 1147-1167.
b) R.M. Scott, V.L. Walker and E.S. Clark, Ibid.
c) W.J. Scott, "Classification of Inland and Shore Waters", Sewage Works Journal, XIV (1942), 1064-1073.
d)W.J. Scott, "Sanitary Studies of Shore Bathing Waters", Bulletin of Hygiene, XXVI, 7 (1951), 702.
e) W.J. Scott, "Connecticut Studies its Shore Bathing", Bulletin of Hygiene, XXXV, 3 (March, 1960), 220.

46. J.E. McKee and H.W. Wolf, op. cit.
B. Moore, op. cit. (1954).
B. Moore, op. cit. (1959).
B. Moore, "A Recent Bacteriological and Epidemiological Study of Sewage Contamination in British Coastal Bathing Waters", Bulletin of Hygiene, XXXVI, 7 (1961), 623-624.

Therefore such an approach might justifiably be considered as equal or superior to the apparently more accurate techniques involving coliforms, E. coli, and enterococci.

The Aesthetic Approach

The aesthetic approach is similar to the sanitary approach in its subjectivity, but it suffers even more from the effects of differential perceptual abilities. Nevertheless it cannot be entirely dismissed from this study since some medical officers of health could conceivably be influenced by it.

Thus none of the commonly used criteria for deciding whether or not a body of water constitutes a health risk is particularly accurate. The level of subjectivity therefore that comes into the decision processes based upon them must be high.

CHAPTER 5

PLACARDING IN PRACTICE: ATTITUDES OF THE DECISION MAKERS

The extent of placarding and the decision making processes of individual medical officers were studied by means of a mail questionnaire. This method was adopted, despite its many faults, for two main reasons. First, the areas where there are extensive beaches in southwest Ontario are relatively far apart and thus personal interviews would have required considerable travelling and involved heavy expenditure; and second, medical officers, particularly in the larger, more important areas are very difficult to contact personally especially during the time available, when many would have been absent on their annual leave.

In order to increase response it was decided to present a list of factors considered important, but in a brief accompanying letter of explanation, which outlined the general nature of the project, it was explained that replies could be made in the form best suited to the medical officers themselves. This was done in order to try to achieve rather more lengthy and detailed replies than would have been possible with a somewhat longer, more direct questionnaire. (Appendix 2.)

Usual questionnaire techniques were used, with the exception that a return, prepaid envelope was not included owing to the fact that the questionnaire was being sent to public bodies.[1] A follow up letter was sent out three weeks after the initial questionnaire, together with a further copy of the questionnaire. (Appendix 3.)

Selection of the medical officers of health to whom to send questionnaires was done on an arbitrary basis, the presence of a large body of water within the area of jurisdiction providing the principal criterion. The covering letters were personally addressed to medical officers of health, the necessary information being obtained from Provincial Department of Health literature.[2]

Initial response to the questionnaire was 39 per cent. This however improved considerably on despatch of the follow-up letter to approximately 85 per cent.

In the replies received there was naturally, in view of the way the questionnaire was set up, a wide variation in the quality of answers. Some medical officers gave very full details and opinions while others gave just the bare facts

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1. J. Nixon, "The Mechanics of Questionnaire Construction", Journal of Educational Research, LVII (March 1954), 481-7.
2. Ontario, Department of Health, List of Officers of the Department of Health, Medical Officers of Health and Secretaries of local boards of health (Toronto, 1966).

some of which conflicted with evidence obtained elsewhere.

The question asking for details of the locations previously placarded was naturally the best answered since it demanded straightforward factual replies as opposed to opinions as did the other questions. Ten authorities admitted to having 'closed' swimming areas on rivers and creeks, and beach areas. In the case of lake beach closures, the Great Lakes not unnaturally were particularly well featured, notices having been posted at various times on all four of the lakes in southern Ontario. Lake Ontario surprisingly displayed a larger number of closures than any of the other lakes, including Lake Erie, despite the notoriety of the latter in respect of pollution. In fact, at one time virtually every beach area from Niagara on the Lake to Cobourg was either placarded or suspect.[3] This situation would appear to be due to the fact that placarding decisions are associated with inadequately treated urban sewage, and the 'Golden Horseshoe' area, through rapid growth and under-investment in essential services, displays great problems in this respect. Very little in the way of placarding appears to have been carried out on the smaller lakes in the resort areas, although some areas are under suspicion and provide subjects for regular and special survey studies.[4] (Fig. 1)

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3. Globe and Mail (20th July, 1966).

4. Muskoka and Kawartha Lakes Studies. O.W.R.C. bulletin. (February 18th, 1966). Study at present being carried out by the Environmental Health Branch on the effect of septic tanks.

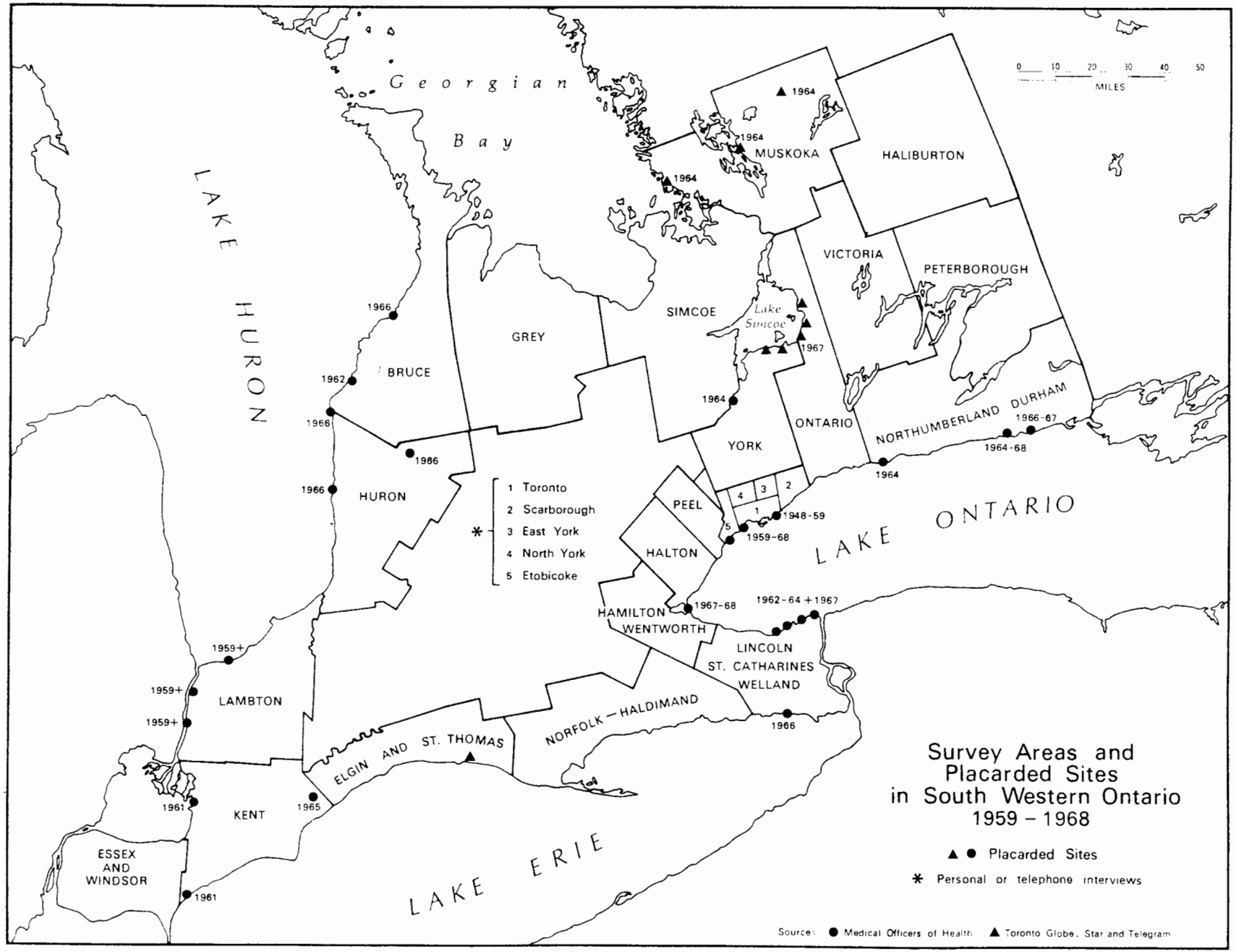
Georgian Bay
LAKE HURON
LAKE ONTARIO
LAKE ERIE
0 10 20 30 40 50
MILES
MUSKOKA
HALIBURTON
VICTORIA
PETERBOROUGH
SIMCOE
Lake Simcoe
GREY
BRUCE
YORK
ONTARIO
NORTHUMBERLAND
DURHAM
PEEL
HALTON
HAMILTON WENTWORTH
LINCOLN
ST. CATHARINES
WELLAND
NORFOLK — HALDIMAND
ELGIN AND ST. THOMAS
LAMBTON
KENT
ESSEX AND WINDSOR
HURON
1 Toronto
2 Scarborough
3 East York
4 North York
5 Etobicoke
1964
1966
1962
1967
1966-67
1964-68
1948-59
1959-68
1967-68
1962-64 + 1967
1959+
1961
1965
Survey Areas and Placarded Sites in South Western Ontario 1959 – 1968
▲ ● Placarded Sites
* Personal or telephone interviews
Source: ● Medical Officers of Health ▲ Toronto Globe, Star and Telegram

Figure 1

The second and third questions included in the questionnaire were designed to assess the ways in which Medical Officers of Health arrived at their decisions to close beaches. Out of fifteen effective replies to the questionnaire as a whole, thirteen dealt in some way with the question concerning the validity of standards suggested by the Ontario Water Resources Board and the Provincial Health Authority. Of these eight stated in effect that they accepted the suggested standards, which define potentially harmful pollution in terms of an arbitrary actual or Most Probable Coliform Count Number, as "reasonable" or "as valid as any known". Of the other replies, two expressed deep dissatisfaction with existing standards. One claimed that the criteria allowed a count "somewhat on the high side", and another stated that any criteria were obviously arbitrary but that the one used, "provided a convenient and useful rule to judge water quality". Only one respondent mentioned a lack of epidemiological evidence, and even then related it specifically to his own area. It may or may not be significant that the immediate predecessor of this medical officer refused to take any action to limit bathing in his area on these very grounds.

Thus, it would appear that the medical officers questioned accept the Provincial Governments agencies criteria without too much critical assessment.

The answers to the question on other factors taken into account prior to placarding revealed however that it would be erroneous to proceed from this and to conclude that these same medical officers use the criteria quite so blindly. Eight replies mentioned that before taking action they would endeavour to trace the source of pollution, and there was an implicit indication that placarding would take place only if the source remained totally obscure or proved to be local. Three medical officers in addition stated that they took into account the fact that certain pollution sources might be easily eliminated and thus warrant direct preventative action, rather than placarding. "Gross visible evidence" was mentioned in one reply as playing a part in the decision making process, whilst another suggested that the potential danger to health of a particular pollutant was in some way assessed. Thus some medical officers of health while stating their approval of the Provincial standards are at the same time using other methods of assessing the quality of the water, and to a certain extent thus admitting the faults of these standards. The situation was summarized by one medical officer who declined to offer any professional views on the standard, but stated ".... it is my practice to use the coliform count only as confirmation of the findings of an overall inspection of the area: a good public health inspector relies not on the numbers on a lab test, but on the knowledge that nearby there

are outfalls of domestic sewage".

The role that chemical pollutants play in persuading medical officers of health to placard areas was not particularly well defined. Responses to the question on this subject, fourteen in number, varied from the five which stated that they were largely irrelevant to bathing to two which expressed great concern. This wide variation in opinion was hardly surprising since it mirrors the confusion which exists in the literature as to the degree of toxicity required to render a stretch of water unusable for recreational purposes. The general impression gained from the replies was that even where chemical pollutants were considered to be a potential menace it was accepted that they provided a lower level of risk than does fecal pollution, and placarding was not the usual measure employed to protect the public from their effects. Strangely in view of the extent of synthetic organic chemical pollutants, particularly in Lakes St. Clair and Erie, and the consequent decline in the aesthetic quality of water in these two lakes, only one medical officer referred to the aesthetic considerations in his answer on this subject.

The way in which medical officers became aware of possible pollution dangers was stated on thirteen answer sheets. Routine tests and surveys were given by ten respondents as the way in which they identified potentially

harmful situations, while two gave general knowledge of the area as their method. Only one reply quoted public complaints as the reason for his actions, a possible reflection on the fact that medical officers by the nature of their jobs tend to be very cautious and thus act considerably in advance of the public. It also means however that medical officers are presuming to see a danger of which the public is completely oblivious, and which they themselves are unable to substantiate. Thus it could be argued that they are unjustifiably withholding recreational facilities from public use.

This general conservatism was also revealed in the answers to the question on the removal of placards, where it was made quite obvious that once a sign is erected it is only taken down when the medical officer and his inspectors are confident that improvement has taken place. Answers to the question as to when placards were taken down yielded three types of replies variously combined. Of the returns, eleven produced usable answers, and of these, nine cited decreases or elimination of pollution, seven mentioning coliform counts as their criterion; six also mentioned correction of the source, and two suggested that they use visible evidence as part of their procedure, and although actual details were omitted, this is presumed to mean that they demanded freedom from visible fecal material.

The three final questions included on the questionnaire involved public reaction to placarding and additional measures taken to try to increase public awareness of the supposed health hazard.

Through the question on extra measures to placarding taken by medical officers, it was hoped that some mention would be made of the legal position, and the possibility of by-laws being formulated. In fact only one medical officer offered any material on the legal aspects of placarding, stating that in his opinion the process was of dubious legality.

The remaining replies to this question concentrated on how they used the mass media and oral reinforcement to support their actions. Newspapers were used by six of the eleven officers replying to this question, television by two, and radio by four. In one of the cases where radio was mentioned it is the exclusive medium employed by the medical officer to inform the public of the pollution situation, and consists of daily reports defining levels of pollution as "slight, moderate and heavy". Oral reinforcements, by lifeguards and police, were mentioned in two replies and another response indicated that telephone enquiries were dealt with in such a way as to further support the original decision.

On the subject of effectiveness of placarding there was

considerable difference of opinion expressed. Six medical officers thought it to be ineffective. It is interesting to note that all but one of the latter group of respondents had jurisdiction over areas which were at one time placarded, a state of affairs which would seem to suggest a prima facie case that to some medical officers placarding is an action which has to be taken regardless of the practical considerations involved. Additional information supplied by six medical officers' departments suggested also that signs were frequently damaged, thus minimizing their usefulness.

Many of the areas to which the mail questionnaire was sent are recreation and vacation centres, and the possibility was originally considered that pressure groups might have altered a medical officer of health's judgement. A question was therefore included to provide an opportunity for stating any objections which had been received to placarding. Six medical officers admitted that placarding in their areas had produced adverse reactions from various bodies, particularly local councils, who in the case of health units have no direct connection with medical officers. At the same time however one emphasized that anger was vented primarily at the source of the pollution rather than at the medical officer of health, who it was assumed was merely carrying out the work for which he had been appointed.

The survey thus revealed that placarding is used in

cases where the water produces "constantly adverse coliform counts", and where sanitary surveys prove unsatisfactory. From the replies received, medical officers seem generally unaware of the doubts expressed over the connection between coliform counts and the incidence of disease and infection, and over the methods of obtaining and interpreting Most Probable Number and actual Coliform counts, but compensate by using subjective appraisals. On the whole, the medical officers displayed very conservative views on the subject of placarding in their stated outlooks toward the recommended standards, the taking down of signs, their reactions to chemical pollutants, and the actual risk involved in bathing in polluted waters.

As to the efficacy of placarding, the public it would seem does take some notice of signs but there will always be people who prefer to make their own decisions on water quality, a situation which finds support in some of the literature.[5]

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5. This view is the one strongly propounded by B. Moore in several of his works. (op. cit.)

CONCLUSION

It was found that there was little evidence in the literature to support the contention that there is a connection between water pollution and disease incidence, except at levels when aesthetic considerations could naturally be expected to reduce the intensity of bathing to a point at which only the foolhardy would participate.

Furthermore it was found that the indices, which have been traditionally used as a basis for decision making actions with respect to water pollution and health, are themselves suspect. Developed as they were, primarily to identify the presence of possible fecal pollution in drinking water, extension of their use to swimming baths and beach areas is highly suspect. In addition partly as a result of the lack of epidemiological evidence of a connection between polluted water and bather-infection risk, accurate standardization of any test results has proved impossible, and a multitude of unjustifiable criteria are therefore being used throughout North America to prohibit the use of extensive recreational resources.

On the whole the replies of the medical officers displayed little knowledge of this situation, and their decisions appear to have been based on the assumption that

there is a risk to be dealt with. Heavy reliance however appeared to be put upon sanitary evidence in addition to mere coliform counts, indicating that the suggested criteria of the Provincial authorities of Ontario are not adhered to as strictly as are similar guidelines used in the United States. On the other hand however, of those medical officers erecting signs, only one failed to mention coliform counts as an important factor in deciding when a once placarded beach becomes safe for public use.

There were indications in replies received from medical officers that they were not entirely satisfied with the measures that they were employing. Strangely enough however their criticisms were concentrated on the administrational difficulties involved rather than on the technical inadequacies of the coliform counts and their interpretation. Their viewpoint appears to be in keeping with the role which they envisage for themselves, of protecting the public from all the health dangers which they can perceive. By its very nature this viewpoint precludes decisions which might expose them to future blame, and induces extremely conservative actions.

Medical officers thus accept that they prefer to err on the side of caution, and it is probably true to say that this type of error is incurred in placarding decisions. Ironically however, as has been suggested, the most common

diseases contracted through water, whether polluted or not, are of the ear, nose and throat, and the indicators which medical officers are at present using to arrive at their cautious decisions do not necessarily identify the presence of harmful organisms of this type. Their caution may thus be falsely based.

There appears to be some doubt as to the effectiveness of placarding. Obviously a certain number of potential bathers heed warnings, but others definitely refuse to pay any attention. Thus as a means of conveying the opinion of the medical officer of health to the public, placards cannot be regarded as wholly successful. The attempts of individual medical officers to use other media to inform the public testify to the fact that they are aware of this situation although they have as yet found no really satisfactory solution.

The literature review demonstrated indirectly that generally the effectiveness of placarding in reducing disease incidence was, to say the least, highly questionable.

Investigation of the views of medical officers of health and the general public with respect to other risk taking activities, and subsequent comparison with their perception of the supposed hazards associated with bathing in polluted water, would yield greater insight into the general background against which the decisions discussed in

this paper are made and interpreted. Furthermore they might indicate more flexible criteria which were more acceptable from both medical and public viewpoints, could find a limited amount of support from the epidemiological evidence available, and would thus lend themselves to more rigid enforcement.

On the epidemiological side it would perhaps be useful if attempts were once more made to identify in statistical terms the risk involved in bathing in waters with certain characteristics. This type of study could be done only with the extensive co-operation of general medical practitioners, but if carried out on a local scale would provide irrefutable evidence of a type which could be put into effective use.

Thus in the cases examined it was found that protection and conservatism have been used as substitutes for sound, scientifically based evidence. Such an attitude is however typical amongst decision makers, whose actions affect or are thought to affect human lives. Possibly new evidence will be produced to either support or refute current attitudes. Meanwhile however, medical officers will continue on account of pollution effectively to close beaches to the public for the purpose of swimming, and thus deprive them of one of the principle aspects of recreational activity in a number of areas.

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APPENDIX 1

WORDING OF PLACARDS USED IN METRO TORONTO

Toronto City

WARNING

Polluted Waters

Persons Bathing

do so at their own risk.

A.R.J. Boyd

Medical Officer of Health.

Source: The Conservation Council of Ontario. Water Pollution in Ontario. Toronto, September 1964.

Etobicoke

WARNING

Polluted water

Persons bathing

do so at their own risk.

Dr. W.M.G. Watts M.D., D.P.H.

Medical Officer of Health.

Source: Telephone communication. 10th October, 1968.

Scarborough (A subsidiary to the main title concerns penalties for defacing notices)

WARNING

The water in this area is polluted and is unfit for bathing.

Dr. J.A. Bull M.D., D.P.H.
Medical Officer of Health

Source: Telephone communication. 10th October, 1968.

North York (Notices no longer posted owing to vandalism.)

Swimming or bathing is prohibited in this area.

By order of the Board of Health.

Carlton Hill M.D.
Medical Officer of Health.

APPENDIX 2 (i)

Geography Department,
University of Toronto,
Toronto 5, Ontario,
August 1968.

Dear Dr.

I am engaged in a research project on water pollution and public reaction, in Southern Ontario, and would like to request your co-operation.

The study is concerned with people's attitudes towards pollution of public beaches, and I am asking selected Medical Officers of Health for information on the extent to which water pollution affects outdoor recreation and the problems arising in connection with efforts to inform the public.

I would be obliged therefore if you could describe the situation in your area and explain the difficulties if any that you have encountered. In order to facilitate this I have produced a list of some of the questions in which I am particularly interested but please do not feel bound by them.

Thank you for your co-operation.

Yours sincerely,

John M. Hewings.

APPENDIX 2 (ii)

1. Names of locations (or military grid references) of placarded water front areas within your district in:

1968		1962	
1967		1961	
1966		1960	
1965		1959	
1964		1958	
1963		1957	

2. What opinions do you have on the validity of standards adopted by the Ontario Water Resources Commission, and the Provincial Health Authorities for calculating the degree of organic pollution?

3. What factors apart from coliform count criteria do you take into account prior to placarding a beach?

4. What is your reaction to chemical pollutants?

5. How did you first become aware of the pollution situation in the locations you have placarded?

6. What factors induce (would induce) you to take down placards?

7. Have you ever taken measures in addition to placarding in order to prevent the public from bathing in waters considered by you to be dangerously polluted?

8. How effective is placarding?

9. Have complaints ever been made about placarding decisions within your area? Brief details would be appreciated if the answer is positive, concerning the nature of the complaints.

APPENDIX 3

University of Toronto
TORONTO 5. CANADA

DEPARTMENT OF GEOGRAPHY
SIDNEY SMITH HALL
100 ST. GEORGE STREET

12th September

Dear Dr. ,

I wrote to you three weeks ago seeking your opinions on the problem of pollution of public beaches, a subject which I am researching at the present time. In order to include your area in my survey I would be very much obliged if you could see your way to replying in the near future.

Yours sincerely,

J.M. Hewings

(J.M. Hewings.)