



## *Project Summary*

# Recreational Water Quality and Health

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The overall objective of this pilot study was to develop and evaluate methods to determine the effect of recreational water quality on the health of persons bathing in fresh waters. Little scientific evidence exists upon which to base water quality standards for the safety of persons using fresh waters for primary contact recreation.

This pilot study was designed to develop: (1) sampling and recruiting methodology of families attending freshwater beaches; (2) survey instruments for telephone interviews to obtain demographic and socioeconomic information, and the collection of prospective data regarding health status of family members; and (3) the sampling design for the collection of certain water quality variables in order to best relate the effect of the recreational water quality on the health of persons bathing in those waters.

Results of this study indicate that it was possible to recruit and follow families via telephone interviews over a three-week period with low attrition rates. A promotional letter used in conjunction with recruitment had no positive effect in reducing the attrition rate.

The demographic characteristics of bathers and nonbathers at the two study beaches were generally similar. Families at the beach with poor water quality had a slightly lower socioeconomic status (SES) than families at the beach having good water quality. The majority of participants in this study were bathers who generally immersed their whole body.

The concentrations of the water variables were found to be significantly different ( $p < 0.05$ ) depending on the time of day and day of weekend that they were collected. On the whole, there were no significant differences ( $p > 0.05$ ) in the water variables when measured at five different water sampling locations at each beach.

This pilot study did not provide specific information about the relationship of health and recreational water quality. However, a subsequent study can now be conducted to survey a large population at beaches with differing water quality to evaluate this relationship.

While these efforts explore how studies might be conducted on fresh water beaches, a similar research program for marine beaches has been completed.

*This Project Summary was developed by EPA's Health Effects Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

## Background Information

Pollution of bathing waters has been a concern to public health officials for some time because of the potential for transmission of infectious diseases. Reports have suggested that contaminated bathing waters may be related to cases of sleeping sickness, sinus infections, intestinal upsets, eye inflamma-

tion, "swimmers' itch," ear infections and leptospirosis.

Although there is no definitive evidence that a relationship exists between water quality and transmission of infectious disease among bathers, there is presumptive evidence suggesting such a relationship. Disease outbreaks involving leptospirosis, chronic skin granulomas, shigellosis, primary amebic meningoencephalitis, and possibly even hepatitis have been associated with recreational waters. These are the more serious illnesses that may be associated with recreational bathing.

Diseases of the eyes, ears, nose and throat, gastrointestinal tract and skin are additional illnesses occurring at relatively higher incidence rates among bathers than nonbathers. These illnesses cannot always be associated with poor quality recreational water.

A few epidemiological studies have attempted to assess incidence of illness with bathing in water containing fecal contamination. These studies reported some of the following results: an increase in the incidence of eye, ear, nose, throat and gastrointestinal tract infections, higher gastrointestinal illness levels in river bathers versus bathers using a swimming pool; no relationship between illness and water quality at salt water beaches; sewage-polluted sea water had a negligible risk to health; higher incidence of gastrointestinal illness between bathers at more polluted salt water beaches; and the rate of gastrointestinal symptoms was higher for swimmers versus non-swimmers at more contaminated salt water beaches compared to the uncontaminated control beaches. An exposure-and-effect relationship between bacterial levels in recreational waters has been convincingly demonstrated only for marine waters.

Variations in water quality standards used for swimming exist because no physical, chemical, or biological parameter has been established to assess water safety for bathing. Several bacteriological surveys of recreational waters have been conducted with the objective of determining water quality changes and safety for use. However, no standards were established for critical minimum total coliform, fecal coliform, fecal streptococci or salmonella concentration that would be safe for human contact. Although most states presently have bacteriological standards and conduct bacteriological surveys for water quality, there is a

paucity of sound epidemiological or laboratory evidence that communicable diseases may be acquired by contact with contaminated water.

The literature indicates that many different types of bathing-related illnesses may be acquired through contact with or ingestion of recreational water. Therefore, it may be unlikely that one bacterial indicator will sentinel all health hazards related to recreational waters. Organisms such as Staphylococci, Streptococci, Clostridia and Pseudomonads are some of the suggested indicators of health hazards for recreational waters. Furthermore, there is no evidence at present to show that bacteriologically clean water may not, on occasion, contain agents that are potential health hazards.

### Project Design and Methods

Two beaches in the Cleveland, Ohio metropolitan area on Lake Erie were chosen for this study. Edgewater Beach is located in Cleveland on the west side and is situated near two point sources of pollution, Westerly Wastewater Treatment Plant and two storm sewer outfalls. The beach at Headlands State Park is 40 km east of Cleveland with no known point sources of pollution.

One hundred families from each beach were systematically selected to voluntarily participate in the study over three weekends in July 1977. Eligibility for participating was based on Cleveland metropolitan area residency and willingness to be contacted by telephone four times within three weeks to answer questions about health and swimming experience.

The initial telephone call following recruitment collected data characterizing the swimming experience and recorded any acute illnesses occurring in swimming and non-swimming participants. The second, third and fourth follow-up telephone calls, made one, two and three weeks after the swimming episode (experience), elicited information on acute illnesses, socioeconomic status and chronic health problems.

A water sampling design was developed to test water parameters at the two beaches. The purpose was to determine if a relationship existed between physical, chemical and/or biological components of the bathing water and the health of the persons bathing in these waters. Five water samples were collected in a systematic pattern at each beach at 0900, 1200 and 1500 hours on

each test day. Each of the 203 water samples were analyzed for total coliforms, fecal coliforms, *E. coli* fecal streptococci, *Pseudomonas aeruginosa*, total staphylococci, pH, chloride, BODs, turbidity, specific conductivity, suspended solids, total solids and temperature. Meteorological data were also obtained.

### Results and Conclusions

This pilot study surveyed a total of 177 families consisting of 634 persons at both beaches during the three weekend recruitment periods.

The attrition rates at Edgewater (30%) and Headlands (15%) beaches during the study period were low. Attrition was directly related to family size at Edgewater but not at Headlands. A promotional letter had no positive effects on reducing the attrition of families of either beach. The age characteristics at both beaches were similar in that the majority of individuals were less than 15 years of age. Participants differed from drop-outs in the 0-4 and 5-14 year old age groups at both beaches. Sex distribution of participants was the same at both beaches when compared with non-participants. A higher percentage of families at Headlands Beach had college or professional school education than those at Edgewater Beach.

Most participants were bathers at Edgewater (60%) and Headlands (89%) beaches. A majority of the bathers (63%) reported not bathing at other times during the study period. Also, fewer people bathed at other times as the study progressed. There were meaningful differences between bathers and non-bathers at either beach with regard to age, sex, race and educational characteristics.

The health information presented is not an analysis of the effects of water quality on health, but demonstrates a method of analysis that could be used for a larger study. In this pilot study there were only two illnesses (21 person-days) reported from Edgewater Beach and 19 (1,470 person-days) reported from Headlands Beach to individuals who only had total body immersion on the day of recruitment.

Chronic disease information should be included in future analysis of health data from beach studies since it may alter susceptibility to infections. The results of the study showed that approximately 850 families for each bathing

beach are needed to have an 80% chance of detecting a difference of 10 per 1,000 between illness rates using a type 1 error of 0.05.

Although this long follow-up period was selected to record infectious illnesses with long incubation periods and determine if the study population could be followed up successfully via telephone for three weeks, a two-week follow-up is recommended as the most appropriate for subsequent studies.

Multiple water samples were collected at each beach to determine differences in these components between: days the samples were collected, the five collection points at each beach, the three daily time periods of collection, and the weekends. All of these variables were analyzed statistically using the analysis of the variance (ANOVA) for two, three and four way interactions. Water variables were compared using Schiffe's Multiple Comparison Test.

Two samples of Lake Erie water were collected by filtration on July 16 and 17, 1977 at Headlands State Park (50 gallons) and Edgewater Beach (63 gallons), respectively. The filters were processed at HERL-Cincinnati by organic flocculation and inoculated to tissue culture cells including: primary African green monkey kidney, primary human embryonic kidney, continuous cell line BGM and continuous line human rhabdomyosarcoma cells, and agar overlay using BGM. A virus isolated from the Edgewater Beach sample using the overlay procedure was identified as Cocksackievirus B3 by use of monovalent Cocksackievirus B3 serum.

The mean concentration for most of the water measurements for Saturday and Sunday generally was found to be significantly different ( $p < 0.05$ ) for both beaches. Significant differences between these water quality variables were most prevalent between 0900 and 1500 hours at both beaches. Generally, there were no differences noted between the five sampling sites at each beach. When weekends were compared by day and time of day, many significant differences ( $p < 0.05$ ) were found for the microbiological, physical and chemical variables.

It was necessary to know the time of day and day an individual was exposed in order to relate health effects of recreational water to some water quality variable. Since major differences observed between the beaches were in the microbiological variables

while the physical and chemical variables were quite similar, only microbiological variables need be included in subsequent studies.

## Recommendations

For future beach studies using the methodology developed in this pilot study, the following changes are recommended:

1. Attrition would be reduced in future beach studies by having the survey workers go directly to the homes of those families who do not have home telephones.
2. Families should be asked to contact the survey workers as they leave the beach to state individually their bathing experience relative to amount of body exposure to the water and length of exposure.
3. Information should be gathered about the health status of bathers and nonbathers on the day of recruitment.
4. A two-week follow-up period is minimally required so that long

incubation periods of various infectious agents (e.g., viruses) can be included in the evaluation.

5. Quality of recreational water can be adequately monitored by sampling the water for microbiological variables at one central location in the bathing area instead of the five locations used in this study, as long as time of day and day of weekend are considered.
6. A large scale study should not be conducted at Edgewater Beach because less than 250 families use this beach during the summer swimming season. Approximately 850 families would have to be recruited to be able to detect a significant difference between the two beaches' illness rate.

The research project on marine beaches led to the development of a criteria based on an exposure response relationship; Health Effects Quality Criteria for Marine Recreational Waters, EPA-600/1-80-031 (September 1980). The protocol developed for the marine project is currently being used on two fresh water beach studies.

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*The complete report, entitled "Recreational Water Quality and Health," (Order No. 82-103 599; Cost: \$12.50, subject to change) will be available only from:*

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