EXECUTIVE SUMMARY

In the spring of 1987, the Governor and the Legislature directed the New Jersey Department of Health (NJDOH) to determine whether microbiological contamination of ocean swimming areas was related to an increased risk of infectious diseases. In response to this directive, the NJDOH, with the support of the New Jersey Department of Environmental Protection (NJDEP) and local health officials, conducted a series of studies. The studies were a major undertaking and included investigations of beach water quality and health effects of ocean and lake water on beachgoers at nine beaches along the New Jersey shore and two inland lakes. The studies required hundreds of water samples and thousands of beachgoer interviews during the summers of 1987 and 1988. A progress report on the work conducted in 1987 was released in March 1988.

The primary goal of the NJDOH ocean studies was to determine whether the chlorinated municipal wastewater discharges from sewage treatment plants or microbiological contaminants from stormwater runoff along the New Jersey coast increased the risk of swimming-associated illnesses. The summer 1987 results were released March 1988. The purposes of this report are to present the study methods and results for the summer 1988 work and to discuss the public health implications of the findings.

Overall, the findings indicate that among swimmers there was no increase in illness associated with sewage or stormwater runoff at any of the study beaches. This result is supported by the finding that ocean beach microbiological water quality was excellent in the summer of 1988.

The beach water quality was found to be excellent in the summers of 1987 and 1988, except for a widely publicized probable sewage treatment plant malfunction that affected an ocean beach area in 1988. Four water quality indicators were used to describe the microbiological contamination of ocean bathing areas; these measures were fecal coliforms, enterococci, the F2 male-specific bacteriophage, and Clostridium perfringens. In 1987 and 1988, levels of all four indicators were very low for nearly all beaches on almost all weekends. Fecal coliform levels were below New Jersey's standard of 200 colony-forming units (CFU) per 100 milliliters (ml) water for all but two beaches on the one weekend when the sewage treatment plant malfunctioned. In addition, the enterococci levels were below the United States Environmental Protection Agency (USEPA) 30-day average guideline of 35 CFU/100 ml for about 95% of the samples. Bacteriophage and C. perfringens levels, which were used for the first time in New Jersey to evaluate beach water quality, also indicated consistently good results.

The 1988 health study focused on examining the causes of Highly Credible Gastrointestinal Illness (HCGI, also known as "stomach virus"), as defined by the USEPA. Other infectious illnesses included in the study were ear infections, eye irritations, skin rashes, and sore throats. Because all of these illnesses may be caused by water contamination and by other factors including person-to-person transmission and because rates of these illnesses are generally quite low, large numbers of people were interviewed in this study. The Ocean Science Advisory Group, composed of representatives from NJDEP, USEPA, the Centers for Disease Control, environmental groups and representatives from academia, provided NJDOH with suggestions on the study design and selection of beaches used for the epidemiological study reported here.

Water samples were taken and beachgoers were interviewed at nine ocean beaches and two lake beaches from June through September 1988. Individual households were selected on the basis of information obtained by interviewers on the beach and were considered eligible for the study based on swimming patterns and age of household members. Eligible households were telephoned within a few days after the beach visit to determine the health status of all household members. A total of 23,458 households were contacted and screened for the study. Many households were found to be ineligible because members of the household did not meet the age criterion, had illnesses at the time of the beach visit, were at the beach for longer than one weekend or in the same week swam in places other than the ocean or lake beach where the household was interviewed. Nearly 70% of the eligible households completed the initial and follow-up surveys, resulting in 16,089 people (25% under the age of 10) participating in the study.

The findings indicate that swimmers at all beaches had higher rates of symptoms than did nonswimmers. This result is consistent with previous studies conducted in Canada and New York. A higher percentage of swimmers as compared to nonswimmers reported symptoms at all ocean and lake study beaches, indicating that the increases were related to the activity of swimming itself rather than the places where people swam. It is well documented that the activity of swimming carries with it an inherent risk of these common health complaints.

Overall, the difference between HCGI ("stomach virus") rates among swimmers and nonswimmers in this study was an excess of 12.2 cases per 1000 individuals (1.2%), compared to excesses of 13.3 per 1000 and 4.0 to 16.0 cases per 1000 reported for Canada and New York (Seyfried and Cabelli, respectively). "Stomach virus" symptoms typically interfered with normal activities for no more than one day and did not require a physician's care or hospitalization.

The most commonly reported illnesses among New Jersey beachgoers were red, itchy eyes and sore throat followed by skin rash, HCGI and ear infections. Such symptoms could result from a number of activities because they are quite common in any population. It is likely that the observed illness rates resulted from factors other than sewage contamination and may have been primarily the result of person-to-person transmission of viruses.

Another important activity of summer 1988 was the shore area medical surveillance effort established through the Medical Society of New Jersey. From June to September 1988 NJDOH maintained a special phone line to receive symptom reports from physicians and to provide consultation to concerned physicians and beachgoers. Less than 20 reports were received by NJDOH.

There are several limitations to the 1988 health study. First, the microbiological water quality was so good, as found by the water quality indicators, that major increases in illnesses would not be expected among swimmers. Second, the extensive media coverage of beach contamination from sources other than sewage appeared to have resulted in significantly reduced numbers of beachgoers, raising concerns that those interviewed in 1988 may not be representative of usual New Jersey beachgoers. Third, the study participants may have been more aware of beach-related concerns because of the publicity and thus may have reported minor illness episodes more often than in previous studies. Fourth, the screening and follow-up interviews had to be relatively brief. Households were screened for eligibility during 10 weekends and were followed up on the telephone a few days after the beach visit. Available time and staffing permitted only essential data gathering on the 16,089 persons in the study. It was not possible to obtain information on other non-swimming related factors that may explain the illness rates observed.

With the above findings in hand, the NJDOH has evaluated the data and developed public health recommendations:

* NJDOH will continue monitoring illness reports with the assistance of local health professionals.

* NJDOH endorses continuation of the weekly ocean water quality monitoring programs conducted by local and state agencies to ensure that sewage treatment plants meet state and federal standards and to provide the public with information about the beach water contamination levels.

* NJDOH recommends that beachgoers heed any official announcement or posting indicating that swimming is restricted based on monitoring results.

* NJDOH will continue to work with NJDEP to protect water quality at all New Jersey beaches.

Ocean beach water quality has improved through better sewage treatment plant design and operation. We believe that continued improvement in beach water can be accomplished through efforts to identify and eliminate sources of contamination and to implement comprehensive pollution control policies.

This health study is one part of an integrated approach to understand and address ocean pollution and its effects on beachgoers. Ocean pollution control activities are vital to ensure the protection of the New Jersey shore and the health of New Jersey's beachgoers.

TABLE OF CONTENTS

FIGURES

TABLES

The progress report of the Ocean Health study addressed the study efforts from June 1987, through August 1987.

The final report of the Ocean Health Study addresses the study efforts from September 1987, through September 1988. Issues and material covered in the preliminary report are reviewed in the final report but are not necessarily presented in their entirety.

The final report is issued in two volumes. This first volume is a summary of the background, methods, results, and discussion. The second volume contains the technical support material and more extensive text.

Copies of the preliminary report and the technical volume are available from the New Jersey State Department of Health at the address below.

New Jersey State Department of Health

Environmental Health Service

Ocean Health Study

CN 360

Trenton, NJ 08625-0360

(609) 633-2043

ACKNOWLEDGMENTS

The New Jersey State Department of Health would like to acknowledge the assistance of the following agencies and organizations without which the Ocean Health Study could not have been completed.

Asbury Park Municipal Government
Atlantic City Department of Health
Atlantic City Municipal Government
Atlantic County Department of Health
Bradley Beach Municipal Government
Cape May County Department of Health
Cheesequake State Park
Island Beach State Park
Lifeguards and Beach Patrols at all beaches
Long Branch Sewerage Authority
Medical Society of New Jersey
Monmouth County Department of Health
New Jersey Marine Sciences Consortium
Ocean City Municipal Government
Ocean County Department of Health
Seaside Heights Municipal Government
Seven Presidents County Park
Ship Bottom Municipal Government
Stevens Institute of Technology
United States Environmental Protection Agency
University of Medicine and Dentistry of New Jersey
    Robert Wood Johnson School of Medicine
Ventnor City Municipal Government
Wharton State Park

An expression of thanks is also owed to the visitors and the New Jersey residents at the beaches who assisted with this study, and in particular to the many individuals who voiced their concerns about the ocean and their interest in preserving the environmental resources of the state.

1. INTRODUCTION

1.1 The New Jersey Coastline

The New Jersey shore areas are a unique environmental resource as well as a tourist attraction for both residents and visitors. Recreational activities at the ocean make important contributions to the quality of life in the State. Protection of New Jersey's shores is the responsibility of state and local government, industries, and citizens.

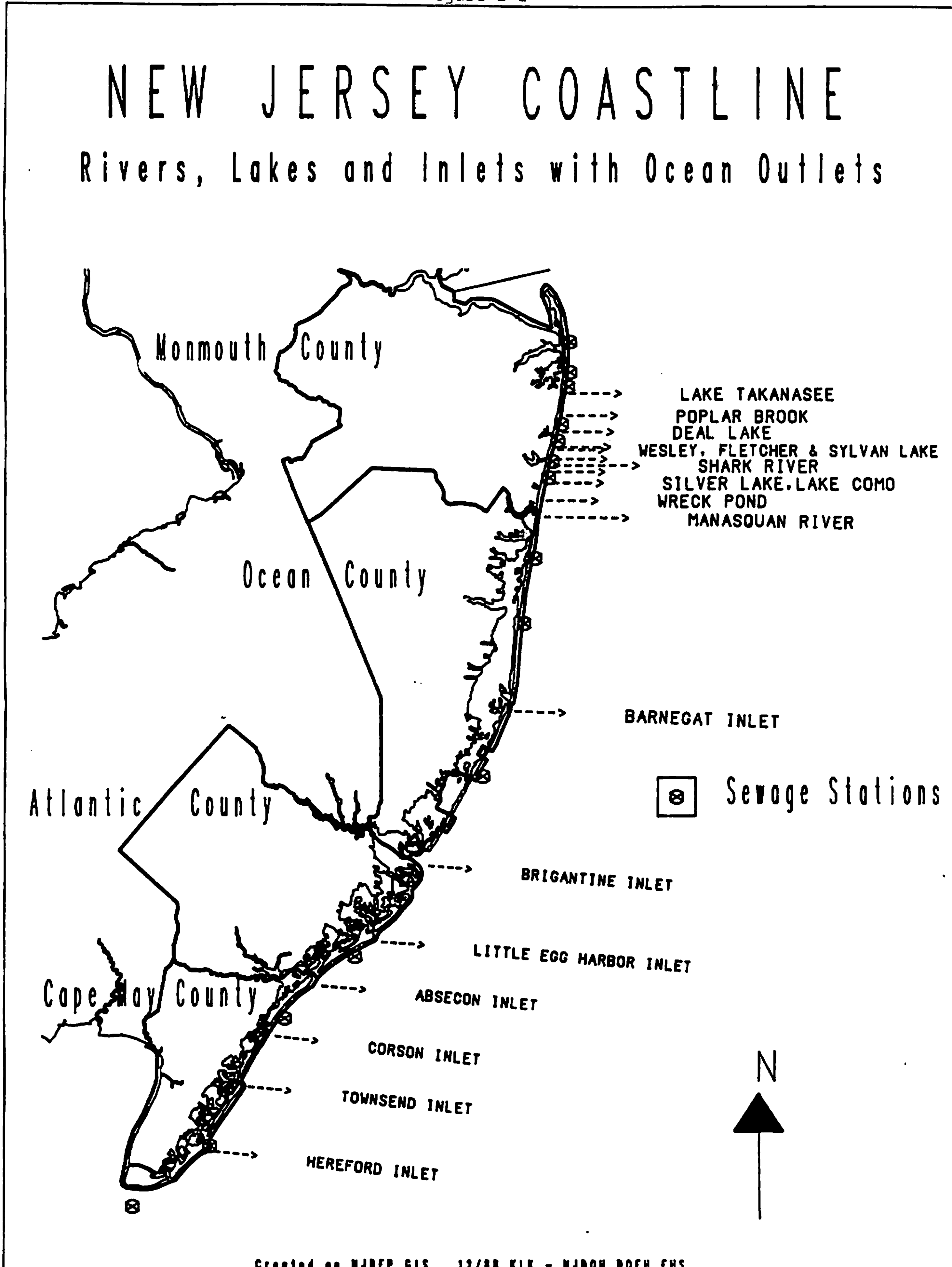
The State's coastline is bounded on the north by Sandy Hook and on the south by Cape May (Figure 1-1). The coastal waters receive outflow from bays to the north and south, ten major lakes and rivers in the north, and nine inlets in the central and south sections of the coast. Programs are conducted by various federal, state, county and local health and environmental agencies to assess water quality and to protect the ocean waters against possible contamination.

1.2 Potential Contamination Sources

Microbiological contamination of ocean water could occur by several routes. The 14 coastal sewage treatment plants (STPs) all use secondary treatment methods and chlorination before discharging into the ocean. Other potential sources of contamination of the ocean include freshwater and bay outflows; intentional or accidental sewer discharges; waste discharges from boats; shedding of microorganisms from bathers; and animal wastes including those from pets, farm animals, or shore birds.

A heightened awareness of the coastal environment has focused the attention of New Jerseyans on potential health effects associated with this recreational resource. A recent issue has been the possible relationship between swimming in water contaminated with microorganisms and the development of infectious illnesses.

Figure 1-1


NEW JERSEY COASTLINE
Rivers, Lakes and Inlets with Ocean Outlets
Monmouth County
Ocean County
Atlantic County
Cape May County
LAKE TAKANASEE
POPLAR BROOK
DEAL LAKE
WESLEY, FLETCHER & SYLVAN LAKE
SHARK RIVER
SILVER LAKE, LAKE COMO
WRECK POND
MANASQUAN RIVER
BARNEGAT INLET
Sewage Stations
BRIGANTINE INLET
LITTLE EGG HARBOR INLET
ABSECON INLET
CORSON INLET
TOWNSEND INLET
HEREFORD INLET
N
Created on NJDEP GIS 12/88 KLK - NJDOH DOEH EHS

1.3 Study Development

The New Jersey State Department of Health (NJDOH) received reports in the fall of 1986 from health care practitioners and the public describing various illnesses attributed to swimming at New Jersey beaches. In general, the described illnesses were common, mild, and brief gastrointestinal or respiratory infections. These illnesses could be transmitted by routes such as contaminated food or between one person and another (for example, by direct contact or through coughing).

In the spring of 1987, the Governor and the Legislature commissioned the NJDOH to determine whether microbiological contamination of the ocean resulting from human activities was leading to an increased risk of infectious diseases. Specifically, a study was designed to determine if an association existed between ocean swimming and gastroenteritis.

The NJDOH formed an advisory group to assist with scientific consultation throughout the study. This advisory group had members from the Centers for Disease Control, New Jersey Department of Environmental Protection (NJDEP), NJDOH, Jersey Shore Medical Center, Medical Society of New Jersey, New Jersey Marine Sciences Consortium, Save Our Shores (SOS), Stevens Institute of Technology, and the University of Medicine and Dentistry of New Jersey - Robert Wood Johnson School of Medicine.

A two-year, comprehensive epidemiological study was planned to combine literature review, laboratory research, and field work. This report provides the scientific background for the study, presents the results of field work conducted during the summers of 1987 and 1988, discusses the implications of the results, and offers recommendations for further work deemed essential for the accomplishment of the study's goals.

2. BACKGROUND

2.1 The Meaning and Limitations of Epidemiology

It is important to recognize both the meaning of epidemiology and its limitations as a science. Broadly defined, epidemiology is the study of the distribution and causes of diseases in human populations. Epidemiology seeks to establish associations between exposures to disease-causing factors and the related health outcomes in large groups of people.

Identifying how illness is transmitted can be difficult when there are many potential infectious agents and many ways to be exposed, as is true of most acute gastrointestinal and respiratory diseases. Determining the infection source of a single case of a relatively common illness is virtually impossible. However, by studying groups of individuals it becomes possible to identify common factors associated with the illness.

2.2 Water Quality

It is commonly accepted that drinking fecally contaminated waters carries an increased risk of acquiring infectious diseases, specifically acute gastroenteritis ("stomach flu"). Levels of coliform bacteria and in some cases enterococci are used as the basis for water quality monitoring to determine whether drinking or swimming water has been fecally contaminated. These indicator microorganisms generally do not cause disease but are associated with fecal contamination having disease-causing microorganisms (pathogens). The indicator levels are reported as colony- or plaque-forming units per 100 milliliters of water (CFU/100 ml or PFU/100 ml, respectively).

Chlorination of sewage effluents decreases the levels of indicator microorganisms. However, not all pathogens are removed during the chlorination of sewage; in particular, the viral agents that can cause gastroenteritis are not necessarily killed by chlorination. The study included two other indicator organisms that are relatively resistant to chlorination. One was the F2 male-specific bacteriophage (phage), considered to be a promising measure of contamination from sewage pipes, STPs, and septic tanks. The second is Clostridium perfringens (C. perfringens), a fecal bacterium with a relatively resistant spore stage that survives chlorination. If the source of microbiological contamination is raw sewage, it is predicted that all four indicators will be present. Chlorinated sewage is predicted to have elevations in C. perfringens and the phage. Samples taken in 1987 from nine New Jersey STPs for the Ocean Health Study confirmed these predictions (Table 2-1).

2.3 Study Components

Generally, there are three major elements of an epidemiological study: a population at risk, the agents of exposure, and the health outcome resulting from exposure. Beach visitors were the population at risk in this study. Swimming contact with microbiologically contaminated ocean water was the major exposure of interest. Finally, the health outcome of interest related to swimming exposure was considered to be gastroenteritis. Other than gastrointestinal infections, illnesses associated with waterborne transmission are relatively uncommon, even with grossly contaminated water.

In addition to an exposed group, an epidemiological study should include a comparison group not exposed to the agent in question. Using information about suspected exposures, illness rates are compared to look for an association between the illness and a particular route of transmission or exposure. If an association can be found, researchers evaluate that association using standard criteria for judging the statistical significance of the results.

TABLE 2-1: MEAN INDICATOR LEVELS IN POSTCHLORINATED EFFLUENTS
New Jersey Ocean Health Study, NJDOH
(composite of three samples at each plant collected in summer 1987)

Sewage Treatment Plant	Indicator Level After Chlorination: Coliforms CFU/100 ml	Enterococci CFU/100 ml	Phage PFU/100 ml	C. Perfringens CFU/100 ml
Northeast Monmouth	~110.0	~15.0	12,000	2,500
Long Branch	~1.3	<1.7	1,600	3,200
Deal Township	<6.5	<1.7	370	10
Ocean Township	<1.4	<1.4	27,000	1,100
Asbury Park	~3.8	<1.4	16,000	4,200
Neptune	60.0	~2.6	96	30
South Monmouth	32.0	19.0	3,000	480
Ocean County, North	~6.3	<1.4	3,100	620
Ocean County, Central	<38.0	<3.5	4,400	130

results in colony or plaque forming units (CFU and PFU respectively) per 100 milliliters of effluent

~ = approximation because at least one but less than half of the values were less than the detection limit of the assay

< = at least half of the values were less than the detection limit of the assay

The numbers of individuals included in the exposed and unexposed groups are chosen by statistical methods. For example, it would take only 6,208 individuals to find a 100% difference (doubling of rates) but 53,099 individuals to find a 30% difference in illness rates. The Science Advisory Group suggested looking for an increase in illness of more than 50% in the exposed group, meaning a sample of about 20,000 individuals.

2.4 The Epidemiology of Gastroenteritis

Viral gastroenteritis may result from contaminated water (one cause of "traveller's diarrhea"), improper food handling ("food poisoning"), or transmission between people under conditions of crowding or poor sanitation. The background rate of gastroenteritis in a population represents the typical levels of disease in that group. Several specific reasons may cause an increase in gastroenteritis over the background rate including: travel-related illness, swimming-related illness, bather-related illness, and exposure to ocean contamination.

Travel-related illnesses could be due to various causes such as poor food handling, increased crowding during vacation, and lax personal hygiene. Swimming-related illnesses, occurring if normal body bacteria penetrate skin or mucous membrane barriers, are nonintestinal (an example is "swimmer's ear"). Bather-related illness can result from person-to-person transmission of infectious agents in a swimming area. A variety of skin, respiratory, and intestinal infectious outbreaks have been reported from swimming in pools and lakes. Finally, infections can result from contact with fecally contaminated water. The expected infection is gastroenteritis, typically occurring as a brief, relatively mild illness with symptoms including fever, abdominal pain, nausea, vomiting, and diarrhea. Swimming in fecally contaminated water is not expected to cause respiratory or other infections.

3. GOALS AND OBJECTIVES OF THE OCEAN HEALTH STUDY

Based on discussions with the Science Advisory Group, the NJDOH developed goals and objectives for the 1988 study. To address public concerns, these goals took a broad perspective, touching on monitoring and environmental areas outside the usual range of NJDOH activities.

3.1 Goals

1. To investigate epidemiologically whether the discharge of chlorinated municipal wastewater from sewage treatment plant ocean outfalls carries with it a risk of swimming-associated illness

2. To determine, if increased risks are present, whether those risks are beyond those predicted from the enterococci levels in the bathing water

3. To evaluate the effectiveness of other sewage indicators to predict the rate of illness following contact with water containing chlorinated sewage

4. To evaluate the effectiveness of chlorination in treatment of sewage prior to release into the ocean

5. To determine whether stormwater runoff containing high levels of the enterococci and fecal coliform indicators but no human fecal input carries with it a measurable risk of swimming-associated illness when discharged into coastal waters

3.2 Objectives

1. To assess the feasibility for using existing methodology in an epidemiological study of ocean water quality

2. To determine the incidence of gastrointestinal and respiratory symptoms following swimming exposure to ocean water containing chlorinated sewage discharged under current disposal practices

3. To determine the incidence of infectious symptoms following swimming exposure to ocean water of varying quality as determined by microbiological assays

4. To determine the water quality index best correlating with illness incidence following exposure to ocean water containing chlorinated sewage

5. To characterize the quality of water at beaches and the oceanographic patterns along the New Jersey coast, including recirculation and exchange patterns

6. To inventory sources of microbiological contamination along the New Jersey shores

4. SUMMARY OF PROGRESS REPORT 1987

The first year of the study focused on performing water quality monitoring along the shore and conducting a pilot epidemiological study to refine the study methods for the large-scale investigation planned for the next year. A progress report was issued March 1988 summarizing the results.

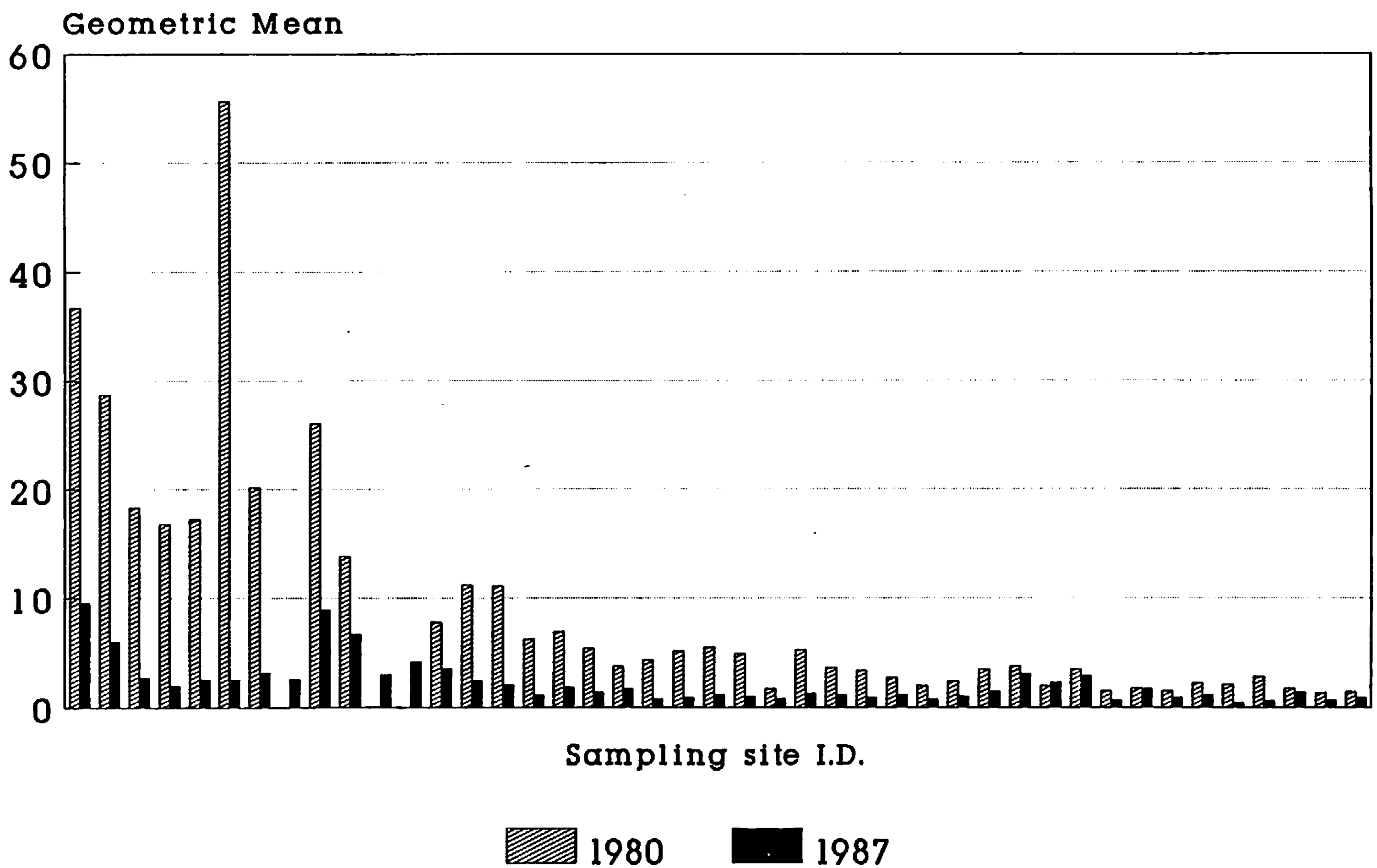
4.1 Water Quality

In order to determine if sewage effluent discharges caused microbiological contamination of the ocean, water was sampled at 43 offshore ocean sites located between the sewage outfall pipes and the swimming beaches. Geometric means for indicator organisms in offshore samples met established federal water quality standards and guidelines. Comparison was also made with previous data from the same sites. Of 40 offshore samples tested in 1980-1981, 38 had lower C. perfringens levels and one had an equal level in 1987 as compared to the earlier testing (Figure 4-1). This suggests that there was no major sewage contamination of offshore waters in 1987 and that an improvement in water quality had occurred over the decade.

In general, when compared to the offshore water samples, beach surf samples had higher levels of fecal coliforms and enterococci but similar levels of viral indicators (C. perfringens and phage). The absence of elevated indicator organisms offshore and the infrequent presence of viral indicators close to the shore suggest that the occasionally increased bacterial levels at beaches may have been unrelated to sewage discharges. Towards the end of summer 1987, efforts increased to better characterize potential land-based contamination sources. Testing of selected lakes, rivers, and inlets identified occasional very high levels of microbiological contaminants, suggesting that freshwater and stormwater flows into ocean water could be a major source of elevated indicator levels.

Figure 4-1

C. Perfringins Geometric Means
EPA Sampling Network
1980 and *1987*



n = 40 sites

4.2 Epidemiology

The pilot epidemiological work during summer 1987 addressed two important areas: investigating the feasibility of doing a large-scale epidemiological field study the following summer and characterizing general public health issues related to ocean bathing. Although the study design was too small for statistical analysis, two observations were made.

First, some beach visitors (up to 5%) had recent infectious illness symptoms. These people represented a potential source of infection transmission for others coming to the beach. Second, there was apparently an increase in gastroenteritis rates among both swimmers and nonswimmers. This suggested that infectious illnesses were being acquired through transmission routes other than through swimming.

Based on the 1987 observations at the beaches, public health questions separate from water quality issues were raised by the NJDOH during the summer. It was noted in several instances that basic personal hygienic standards were not met, increasing the risk for transmitting infections such as gastroenteritis. These observations included lack of handwashing facilities in public restrooms, children in diapers entering the swimming zone, and poor food handling practices.

The progress report made the following recommendations:

1. conduct a large-scale epidemiological study
2. characterize sewage treatment plants more fully
3. reevaluate toxic pollutant discharge into the ocean
4. reevaluate all ocean discharge permits
5. carry out targeted compliance monitoring of ocean dischargers
6. evaluate the impact of stormwater on ocean water quality
7. upgrade coastal sewage treatment plants
8. expand ongoing water quality monitoring

After discussions with the Science Advisory Group, the NJDOH committed to conducting a single large-scale epidemiological study during the summer of 1988 with a goal of 20,000 interviews.

5. COMPONENTS OF STUDY DESIGN

In order to determine rates of gastrointestinal illnesses, a large-scale epidemiological investigation was required to estimate the association between illness, swimming, and ocean contamination. Based on the scientific literature, certain predictions were made ahead of time: children would have infectious illness rates than adults, swimmers would have higher rates than nonswimmers, and travelers would have higher rates than those staying at home. The NJDOH study investigated if **an excess above the expected increase in illness rate** occurred after ocean swimming.

The design for the Ocean Health Study was based on previous similar epidemiological investigations. The three study components were specifically defined as:

1. Population at Risk: households with children visiting the beach for a weekend, with children defined as under 10 years of age
2. Exposure: swimming status (swim, wade, dry) and water quality
3. Health outcome: acute gastroenteritis occurring within four days of the beach visit, defined as symptoms of highly credible gastrointestinal illness (HCGI)

Gastroenteritis could result from traveling or swimming activities including infections acquired from swimming in sewage contaminated water. Eye and respiratory infections would not result from swimming in sewage contaminated water. To distinguish between illness rates due to travel, swimming, and swimming water contamination, the study also included an analysis of nonintestinal infections.

Some limitations of the study design were recognized initially. Illnesses were self-reported, rather than relying on medical diagnosis, because with mild symptoms most individuals do not see a doctor. A single respondent provided the health information for an entire household and could introduce bias. Sampling only approximated the actual water quality.

6. SHORE STATUS in 1988

As judged by the observations of interviewers, local health officers, and NJDOH personnel, the 1988 beach attendance was decreased when compared to 1987. Explanations for the lessened use of the coastal recreational areas included an altered national economy, unfavorable water temperatures, and adverse events involving littering of coastal beaches or ocean water contamination.

Although air temperatures were higher than average during the summer of 1988, water temperatures were lower than normal throughout the summer. In August, water temperatures measured by NJDOH were as low as 55° F and usually did not exceed 70°, with air temperatures above 90°. As a consequence swimming activity was curtailed by many individuals.

There were 12 major pollution events during the summer that impacted on coastal swimming beaches. Household trash washed ashore on two occasions. Medical wastes or drug paraphernalia were found on beaches six separate times. A sewage treatment plant may have been the cause of microbiological contamination that intermittently closed beaches along a 2.5 mile stretch of coast for several weeks. There were three other limited beach closures, one due to a broken sewer pipe, one due to reduced water quality, and one because of "grease balls" washing ashore.

There was a marked level of concern about ocean swimming and safety among the general public. The extensive media coverage seemed to create the impression of widespread water quality problems, although this was not substantiated by the small number of beach closings during the entire summer.

7. STUDIES OF CONTAMINATION SOURCES

The 1987 monitoring results demonstrated a tendency for better water quality offshore than in the nearshore surf, suggesting that land-based sources of contamination could have an important impact on beach water quality. Three areas were identified for further investigation: stormwater, freshwater lakes, and sewage treatment plants.

7.1 Stormwater

During a rainfall, animal wastes can enter the drainage from streets and yards and eventually be discharged into the ocean through lakes, rivers, and stormdrains. Animal wastes have coliforms and enterococci but few, if any, microorganisms pathogenic to humans and so can cause high indicator levels in the water without illness risk for swimmers. Previous monitoring had found higher indicator levels after rainfall, suggesting that stormwater and not sewage was contributing the microbial contamination.

A detailed microbial characterization of stormwater was done in 1988 on samples taken from stormdrains with no evidence of sewer connections and with no chlorination. The stormwater had elevations in bacterial but not phage levels (Table 7-1, Figure 7-1). Since the phage has been cultured from sewage waste even after chlorination, this indicator organism permits some level of discrimination between elevated bacterial levels due to the stormwater and those due to sewage.

7.2 Freshwater Lakes

In 1987 samples were collected from the ocean and from freshwater lakes draining into the ocean. The highest bacterial indicator levels were in freshwater lakes, not in ocean water. This suggested that stormwater draining from lakes to the ocean could be causing elevated indicator levels, although the stormwater lacked human sewage and the associated pathogens.

TABLE 7-1: INDICATOR LEVELS IN STORMWATER SAMPLES
New Jersey Ocean Health Study, NJDOH
(data collection period 4/7/88 to 6/8/88)

		Indicator Organism			
Site	Date	Coliform CFU/100 ml	Enterococci CFU/100 ml	Phage PFU/100 ml	*C. perfringens* CFU/100 ml
1	4/7/88	93.3	160.0	<0.5	150.0
2	4/7/88	525.0	770.0	<0.5	53.0
3	4/7/88	230.0	171.6	<0.5	375.0
4	4/7/88	168.3	17,333.0	<0.5	1,050.0
5	4/7/88	1,826.0	3,100.0	<0.5	695.0
6	4/7/88	38.3	43.3	1.0	148.0
7	4/7/88	1,417.0	1,366.0	<1.0	102.0
8	4/7/88	40.0	148.3	<0.5	50.0
9	5/18/88	6,400.0	1,066.6	<0.5	>300.0
10	5/18/88	6,000.0	8,550.0	<0.5	>300.0
11	5/19/88	11.6	16.6	<0.5	29.5
12	5/19/88	113.3	58.3	<0.5	52.5
13	6/8/88	1.6	1.6	<0.5	2.5
14	6/8/88	121.6	126.6	<0.5	<0.5
15	6/8/88	1,883.0	350.0	<0.5	27.0
geometric mean		220.2	283.7	0.5	72.3
USEPA level		50.0	35.0	na	na

assays in colony and plaque forming units (CFU and PFU respectively) per 100 milliliters water

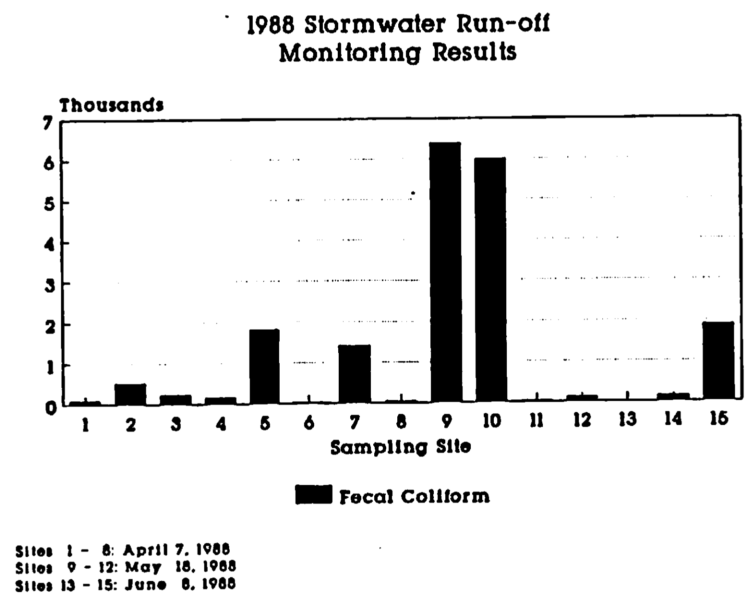
all single samples

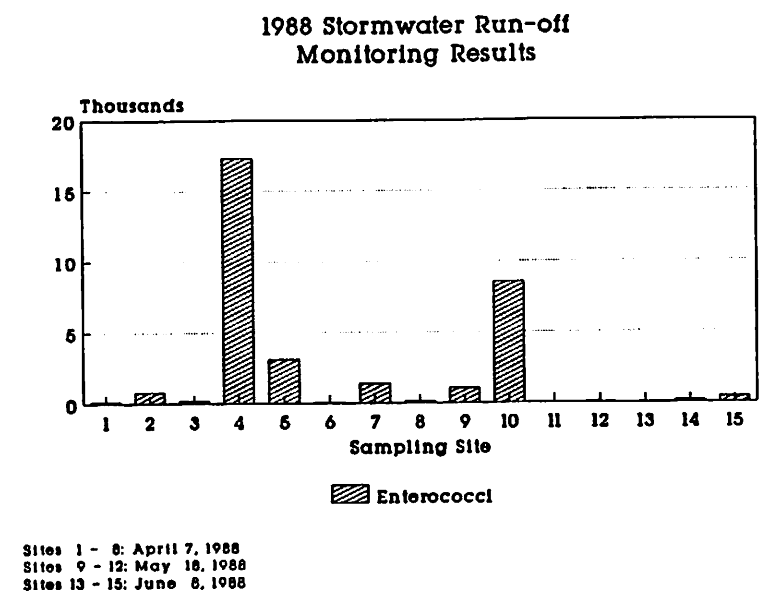
United States Environmental Protection Agency standard is 50.0 CFU/100 ml for fecal coliforms for a 30-day average

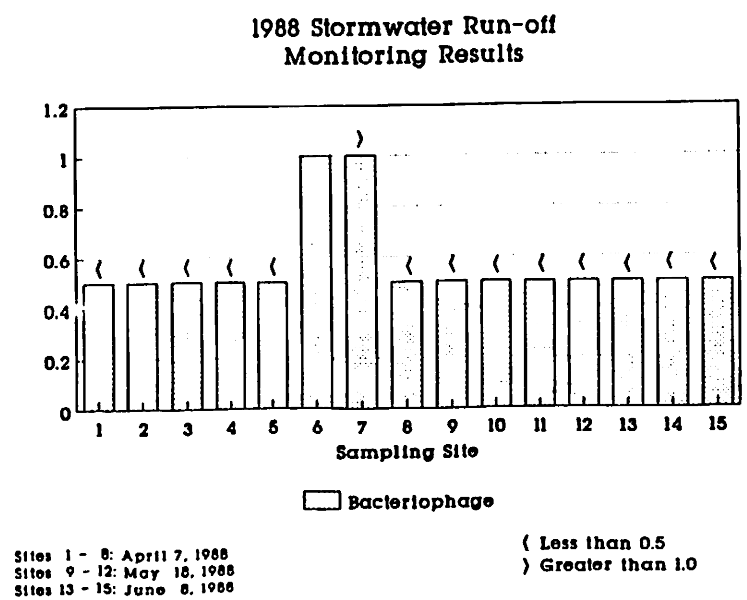
United States Environmental Protection Agency guideline is 35.0 CFU/100 ml for enterococci

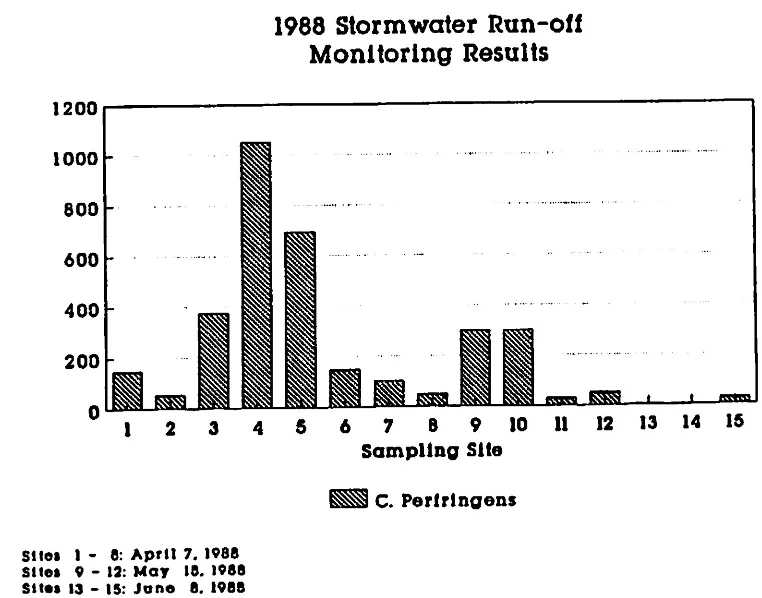
United States Environmental Protection Agency standards and guidelines not available (na) for *C. perfringens* and phage

Figure 7-1 Stormwater Monitoring Results









7.3 Oceanography and Sewage Treatment Plant Discharges

A study of a typical coastal STP was carried out using dye tracers and water quality monitoring. The results indicated that a highly effective outfall pipe diffuser design, combined with ocean circulation, prevented effluent buildup in offshore waters. Ocean circulation was complex with large differences in physical conditions occurring over small distances.

At no time, including a period when chlorination was discontinued, did effluents reach the shoreline to produce enterococci or fecal coliform levels of even the slightest health concern. The enterococci levels were markedly less than the guideline recommended by the United States Environmental Protection Agency (USEPA). The phage, which parallels the environmental behavior of intestinal viruses, did reach the beach in measurable but very low levels when chlorination was discontinued and on one additional day.

7.4 Cooperative Coastal Monitoring

The routine data from the 1987 NJDEP Cooperative Coastal Monitoring program had weekly results for 161 coastal stations from Sandy Hook to Lower Township in Cape May. Geometric means for the fecal coliform counts were generally quite low. There was a definite tendency for coliform counts to increase after rainfall, presumably reflecting stormwater drainage.

7.5 Overview

These studies of lakes, stormwater, ocean water quality, and oceanography demonstrate both the complexity and the multiplicity of coastal sources of microbiological contamination. Stormwater was repeatedly identified as a major source of bacterial contamination of swimming waters, often in the absence of human fecal contamination and the concomitant health risk. STP contribution to contamination at the beach was minimal under the meteorological and oceanographic conditions during the study.

8. EPIDEMIOLOGICAL STUDY METHODS

8.1 Selection of Beaches

Beaches were selected for the summer 1988 study, based on input from the Science Advisory Group, data obtained in 1987 and on information from county and municipal health officers. Since no beach was expected to have uniformly poor water quality, sites for the 1988 study included some that might occasionally have microbiological contamination from sources such as outfall pipe sewage, estuaries, stormwater, or freshwater inlets. Additionally, selected beaches shared certain characteristics including an easy public access, a predominant family orientation, and a high rate of usage for weekend trips. Beaches were also selected so that samples could be transported to the NJDOH laboratory in a timely manner.

The initial study sites included a minimum of two beaches in each of the northern, central, and southern sections of the coast. In response to low beach attendance, sites were added during the course of the study in order to obtain sufficient numbers of study participants. Lake beaches and two relatively uncontaminated ocean beaches were included in the study to help distinguish between swimming- or bather-related illness and contamination-related illness. The final study sites were ocean beaches at Long Branch, Asbury Park, Bradley Beach, Seaside Heights, Island Beach State Park, Ship Bottom, Atlantic City, Ventnor, and Ocean City, and lake beaches at Wharton and Cheesequake State Parks.

8.2 Data Collection

The beach interview was brief, designed to screen and enroll households rapidly. A household was excluded for any of the following reasons: unwillingness to participate, preexisting infectious illnesses among household members, only adults at the beach, or anticipated swimming at sites other than the beach. In order to describe exposure by location, water quality monitoring was done at the same beaches and at the same time periods as the interviewing. Results for an indicator organism were reported for a given beach as a geometric mean for the entire weekend (beach-weekend).

A telephone interview was conducted three to four days after the beach interview to confirm swimming status, to determine health status, and to identify other potential exposures to infectious agents for the household members. The health outcome of primary interest was highly credible gastrointestinal illness (HCGI), which included vomiting, diarrhea with fever, or severe diarrhea. Other health outcomes included eye, upper respiratory, and skin symptoms. Exposures of interest related primarily to possible transmission routes of gastroenteritis at the beaches and at home.

During the interviews, the following information was collected for each person in households participating in the study:

1. Demographics: age, sex, telephone area code, and beach visited.

2. Exposure: date of beach visit, associated indicator organism levels for the weekend, swimming status (swim, wade, dry, at home), swimming at sites other than the interview beach.

3. Presence or Absence of Symptoms: fever, sore throat, ear ache or ear infection, red or itchy eyes, skin rash, diarrhea, vomiting, stomach ache or stomach pains, highly credible gastrointestinal symptoms (vomiting or diarrhea with fever, diarrhea leading to staying at home or visiting a doctor, stomach ache with fever).

4. Other Risk Factors: index of housing crowdedness, public restroom use, consumption of purchased food or beverages, shellfish consumption (cooked or raw), contact with day-care, contact with ill neighbor or friend.

5. Severity of Gastrointestinal Symptoms: days staying home from work or school, physician visit, hospitalization.

The information was entered into a computer file with all records kept confidential.

9. MONITORING RESULTS

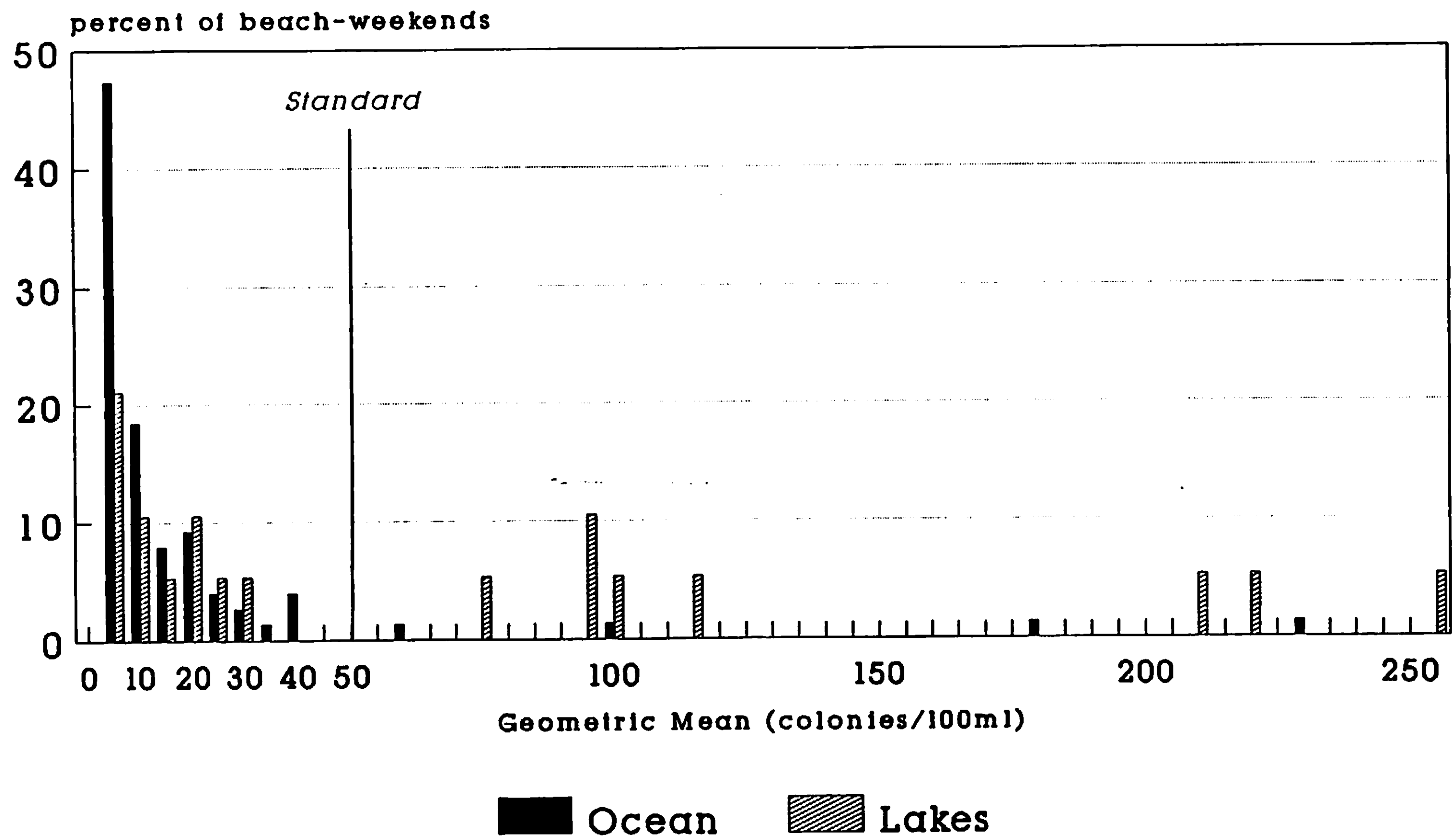
Water quality monitoring was done in summer 1988 to provide exposure information for the epidemiological study. There was water sampling during ten weekends of the study at a total of nine different ocean beaches and two lake beaches. Not all sites were sampled during all weekends due to weather conditions, the addition of new locations during the course of the summer, and temporary closings at certain study beaches. Water quality results were available for a total of 76 ocean beach-weekends and 19 lake beach-weekends.

Overall no beach had consistently poor results and water quality was very good. An exception was the third weekend, when elevated indicator levels occurred at a few beaches due to a probable STP malfunction. As a result there were four beach weekends when geometric means exceeding the USEPA 30-day average coliform standard of 50 colonies per 100 milliliters water (CFU/100 ml) (Figure 9-1). On three occasions, ocean beaches had weekend geometric means exceeding the enterococci recommendation of 35 CFU/100 ml (Figure 9-2). Phage levels were quite low, with the exception of one weekend when two beaches had elevations during the third weekend (Figure 9-3). The C. perfringens levels varied through the summer, but with accompanying phage elevations were unlikely to be of sewage origin (Figure 9-4). There are no standards for C. perfringens and phage. In general, the lake water quality monitoring showed higher bacterial levels for both coliforms and enterococci than at the ocean. Low C. perfringens and phage levels at the lakes suggested that there was no sewage contamination source.

Two ocean beaches had been designated at the beginning of the study as comparison beaches based on the absence of potential contamination sources and on previous results from monitoring showing good water quality. The comparison beaches had low indicator levels and did not show major variability in water quality over the entire summer.

FIGURE 9-1

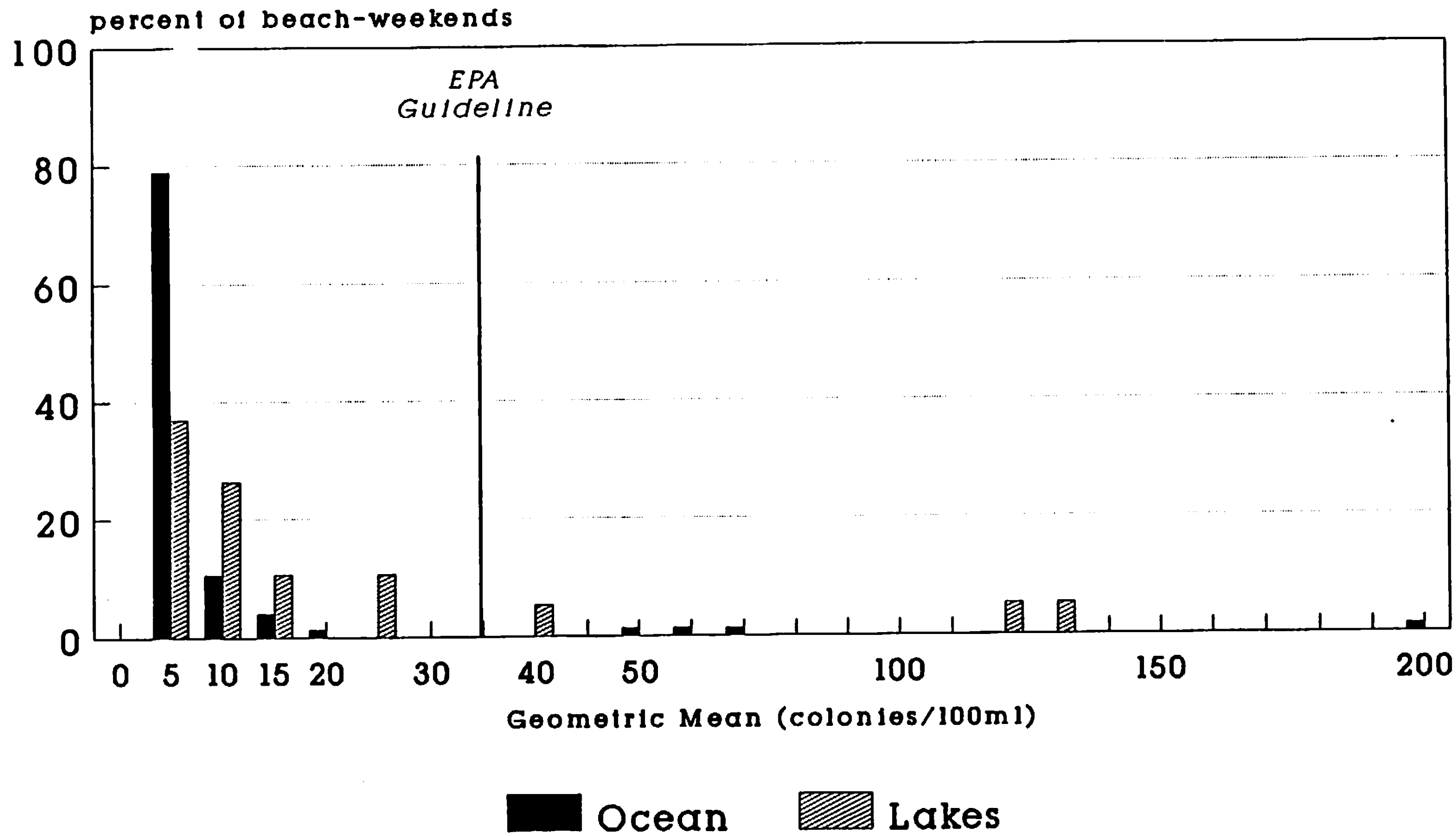
Fecal Coliform
Geometric Means
NJDOH 1988 Sampling



Ocean n=76, Lakes n=19 beach-weekends
Total number of samples:
Ocean = 469, Lakes = 45

FIGURE 9-2

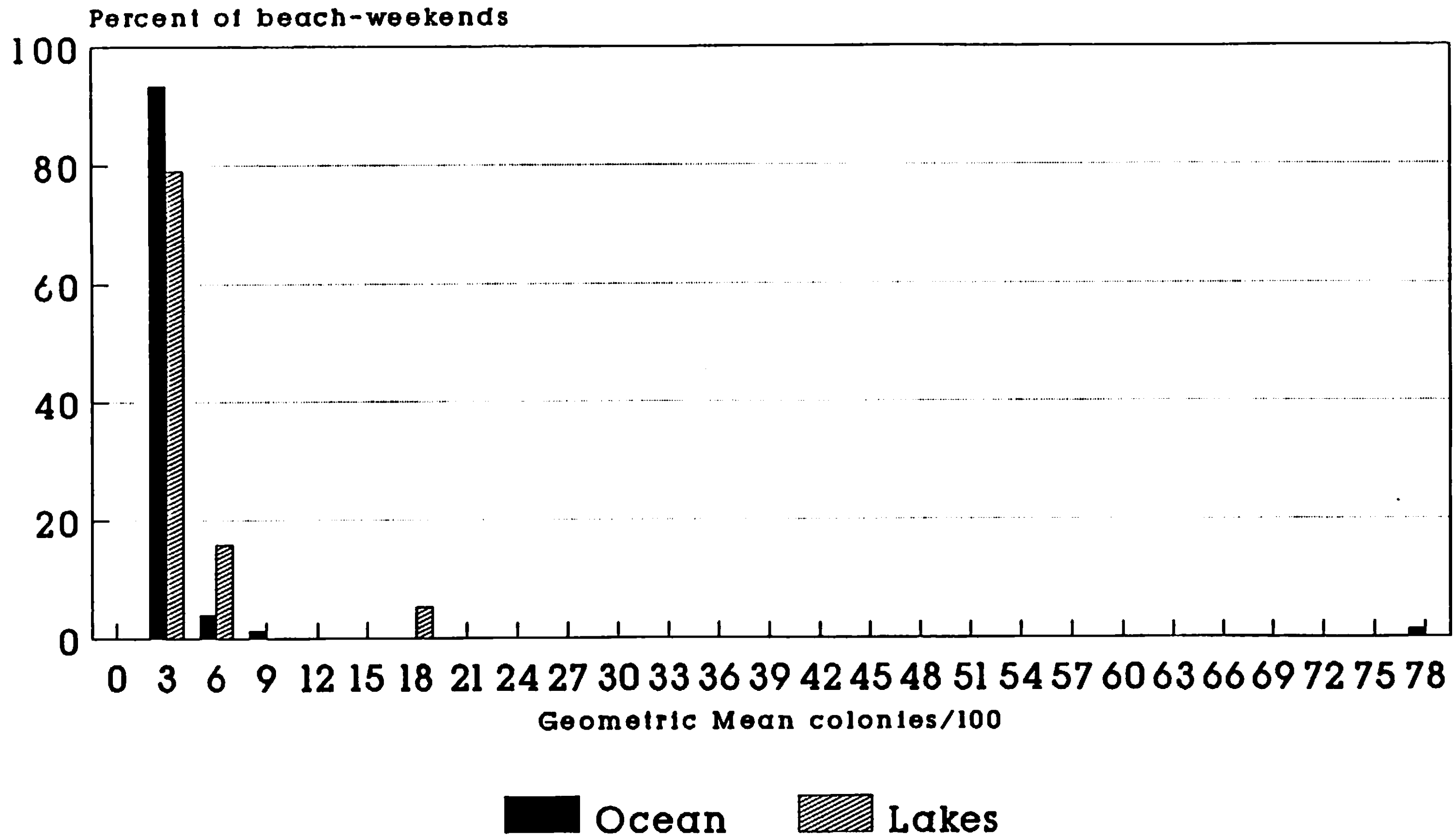
Enterococci
Geometric Means
NJDOH 1988 Sampling



Ocean n=76, Lakes n=19 beach-weekends
Total number of samples:
Ocean = 469, Lakes = 45

FIGURE 9-3

Bacteriophage
Geometric Means
NJDOH 1988 Sampling

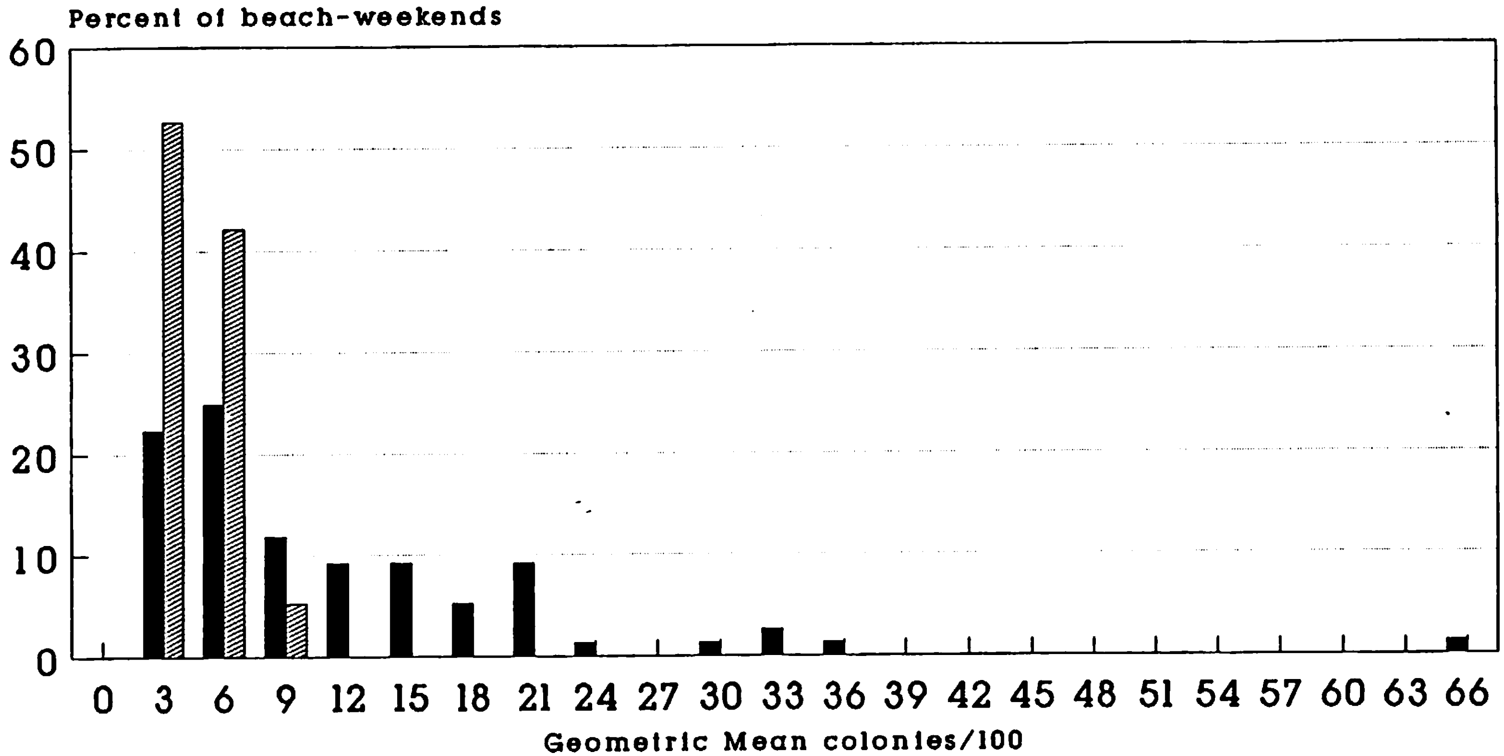


Ocean n=76, Lakes = 19 beach-weekends
Total number of samples:
Ocean = 469, LAkes = 45

No Standard exists

FIGURE 9-4

Clostridium Perfringins
Geometric Means
NJDOH 1988 Sampling



Ocean n=76, Lakes = 19 beach-weekends
Total number of samples:
Ocean = 469, LAkes = 45

No Standard exists

10. EPIDEMIOLOGY RESULTS

10.1 Numbers of Interviews

Interviewing was conducted on 10 weekends from June 18th through September 3rd. There were a total of 76 ocean beach-weekends and 19 lake beach-weekends in the study where a beach weekend equals two days at one specific beach location.

There were 23,458 households approached for interviews, and 7,792 households (33%) were found eligible. The majority of households were excluded because the duration of the shore visit was longer than a weekend (20%) or household members were swimming elsewhere than in the ocean (20%). Of all households found eligible at the beach interview, 69% of the households completed the telephone interview.

The final study population of 5,378 households had 16,089 participants (Table 10-1). There were 11,447 (72%) ocean visitors and 4,642 (29%) lake visitors. The population was 45.5% male and 54.5% female, and 25% of ocean visitors and 37% of lake visitors were children under the age of 10. At lake beaches as compared to ocean beaches, there was a higher proportion of children (37%), a lower proportion of whites (45.6%), and a higher proportion of swimmers (75%).

10.2 Symptom Rates

The pattern of symptom reporting (most to least frequent) was similar for ocean and lake sites (Table 10-2). Sore throat was the most commonly reported symptom for ocean beach visitors while red, itchy eyes were most commonly reported for lake visitors. Ear infections were the least common complaint followed by HCGI and skin rashes. There were 1,067 ocean visitors who had one or more of the symptoms for a rate of 93 cases per 1000 study participants (93/1000), and 665 lake visitors with one or more symptoms for a rate of 143/1000.

TABLE 10-1: AGE, GENDER, AND ETHNICITY OF STUDY PARTICIPANTS
New Jersey Ocean Health Study, NJDOH
(data collected 6/18/88 to 9/3/88)

	Ocean		Lake		Total	
Characteristics	number	percent	number	percent	number	percent
Total	11,447		4,642		16,089	
Sex						
male	5,217	(45.6)	2,100	(45.2)	7,317	(45.5)
female	6,230	(54.4)	2,542	(54.8)	8,772	(54.5)
Age						
under 10	2,861	(25.0)	1,701	(36.6)	4,562	(28.4)
10-49	7,446	(65.0)	2,811	(60.6)	10,257	(63.8)
50+	1,140	(10.0)	130	(2.8)	1,270	(7.9)
Ethnicity						
white	9,766	(85.3)	2,117	(45.6)	11,883	(73.9)
black	248	(2.2)	586	(12.6)	834	(5.2)
hispanic	918	(8.0)	1,682	(36.2)	2,600	(16.2)
other	515	(4.5)	257	(5.5)	772	(4.8)
Swimming status						
got head wet	5,189	(45.3)	3,466	(74.7)	8,655	(53.8)
waded	3,696	(32.3)	662	(14.3)	4,358	(27.1)
at beach, not in water	2,562	(22.4)	514	(11.1)	3,076	(19.1)

TABLE 10-2: SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Symptom	Ocean		Lake	
	number	rate	number	rate
Ear infection	159	13.9	89	19.2
HCGI	175	15.3	124	26.7
Skin rash	244	21.3	153	33.0
Red, itchy eyes	338	29.5	258	55.6
Sore throat	407	35.6	202	43.5
One or more symptoms	1,067	93.2	665	143.3

HCGI = highly credible gastrointestinal illness symptoms

Ocean beach visitors N = 11,447; Lake beach N = 4,642

By age-gender groups, children were at highest risk for most of the symptom categories and overall were more likely to report one or more symptoms than were adult males or females (Table 10-3). The most commonly reported symptom among children at ocean beaches was red eyes, followed by sore throat and skin rashes. For lakes, the most commonly reported symptom among children was red eyes, followed by HCGI and skin rash. Ear infections were least common among children at both beach types. The rate for reporting one or more symptom was 115/1000 for children at ocean beaches and 174/1000 at lake beaches.

By swimming status, swimmers had higher rates for all symptoms than waders or nonswimmers at both ocean and lake beaches (Table 10-4). The most commonly reported symptom among swimmers at ocean beaches was sore throat, followed by red eyes and skin rash. For lakes, the most commonly reported symptom among swimmers was red eyes, followed by sore throat and skin rash. Ear infections were least common among swimmers at both beach types. The rate for reporting one or more symptoms was 120/1000 for swimmers at ocean beaches and 162/1000 at lake beaches. Waders had illness rates intermediate between those of swimmers and nonswimmers for most symptoms.

The illness rates by swimming status were compared for two selected comparison ocean beaches and the remaining ocean beaches, excluding interviewing information from one weekend for the comparison beaches when contamination may have occurred (Table 10-5). The two ocean beach groups, comparison and remaining beaches, did not differ greatly in illness rates for any of the symptoms although the comparison beaches had slightly lower reporting rates for HCGI, ear infections, and skin rash. Overall, the rate for reporting one or more symptoms was 122/1000 for swimmers at the two comparison beaches and 121/1000 at the seven remaining ocean beaches.

TABLE 10-3: SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY AGE AND GENDER
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Group	HCGI	Sore Throat	Ear Infect.	Red Eyes	Skin Rash	One or More
Ocean						
Children under 10	27.3	33.9	16.8	37.4	33.2	115.0
Males, age 10+	8.5	32.1	13.0	27.6	14.1	81.3
Females, age 10+	13.5	39.2	12.9	26.3	19.9	89.6
Lake						
Children under 10	50.0	38.2	16.5	67.6	41.2	174.0
Males, age 10+	16.5	37.7	19.6	49.5	19.6	114.7
Females, age 10+	10.8	53.4	21.6	48.0	34.8	133.7

HCGI = highly credible gastrointestinal illness symptoms

Ocean beach N = 2,861 children, 8,586 adults
Lake beach N = 1,701 children, 2,941 adults

TABLE 10-4: SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY SWIMMING STATUS
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Group	HCGI	Sore Throat	Ear Infect.	Red Eyes	Skin Rash	One or More
Ocean						
Got head wet	20.8	44.5	19.7	41.0	24.3	119.9
Waded	12.2	32.5	8.7	23.8	22.5	81.4
Not in water	8.6	21.9	9.8	14.4	13.7	56.2
Lake						
Got head wet	30.9	45.6	21.9	69.0	35.2	162.1
Waded	15.1	43.8	16.6	19.6	31.7	107.3
Not in water	13.6	29.2	3.9	11.7	19.5	62.3

HCGI = highly credible gastrointestinal illness symptoms

Ocean beach N = 2,861 children, 8,586 adults
Lake beach N = 1,701 children, 2,941 adults

TABLE 10-5: SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY SWIMMING STATUS AND OCEAN BEACH GROUP (COMPARISON VS REMAINDER OF OCEAN BEACHES)
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

	Symptom											
	HCGI		Sore Throat		Ear Infect.		Red Eyes		Skin Rash		One or More	
Swimming Status	comp.	other	comp.	other	comp.	other	comp.	other	comp.	other	comp.	other
Swam	18.7	22.2	48.0	48.0	16.4	21.8	40.2	42.7	22.8	25.0	122.5	120.9
Waded	6.2	12.7	24.3	24.2	11.1	6.6	23.8	23.1	19.5	22.1	70.8	81.6
Not in	15.5	9.0	19.7	19.7	7.1	15.4	10.8	20.2	17.2	17.3	55.4	67.2

excludes 7/9/88-7/10/88 for comparison beaches

HCGI = highly credible gastrointestinal illness symptoms

rates directly standardized to the age-gender distribution of the total ocean beach population

10.3 HCGI Rates

By age group and swimming status, the risk of HCGI infection was highest for children swimming at lakes and lowest for adult nonswimmers at ocean beaches (Table 10-6). The children swimming at lakes had significantly higher HCGI rates than children swimming at ocean beaches. None of the other comparisons for oceans and lakes achieved statistical significance.

Among swimmers and waders, children had significantly higher HCGI rates than adults (Table 10-7). Among adult ocean visitors, swimmers had statistically higher HCGI rates than nonswimmers (Table 10-8).

Of 175 individuals with HCGI after ocean visits, 58 (33%) stayed home for a total of 70 days. Of 124 individuals with HCGI after lake visits, 31 (25%) stayed home for a total of 56 days. There were 45 ocean visitors and 28 lake visitors visiting a physician because of HCGI.

10.4 Anecdotal Reports

During summer 1987, SOS conducted a campaign to collect self-reports of illnesses occurring after ocean visits. A consultant with both medical and epidemiological experience received over 1000 reports from SOS. As previously agreed, the consultant reviewed a subset of the reports. The reported complaints included infections of eyes, ears, skin, and gastrointestinal tract with no overall pattern. The consultant concluded and reported to NJDOH that there might be value to such reports if used to initiate investigations but that there was no value to a retrospective epidemiological study of the reports. There was further effort to gain information from indepth telephone interviews of 50 people. Again, illness reports were scattered. There was no clear pattern relating a particular kind of illness or the intensity of illness to a specific beach, the frequency of exposure, or particular activity.

TABLE 10-6: HIGHLY CREDIBLE GASTROINTESTINAL SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY SWIMMING STATUS, AGE GROUP, AND BEACH TYPE
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Group	HCGI Rate		Lake vs. ocean rate ratio	95% Confidence interval
	Ocean Beaches	Lake Beaches		
Children				
Swam	34.1	54.4	1.7 *	1.2 - 2.4
Waded	19.8	31.3	1.6	0.6 - 24.0
Not in water	17.1	13.5	0.8	0.1 - 7.0
Adults				
Swam	15.1	14.3	0.9	0.6 - 1.5
Waded	9.5	8.5	0.9	0.3 - 2.7
Not in water	7.2	13.8	1.9	0.8 - 4.8

* p value (two-tailed) < 0.05

HCGI = highly credible gastrointestinal illness symptoms

children N = 1,553 swam, 958 waded, 350 not in water for ocean beaches
N = 1,435 swam, 192 waded, 74 not in water for lake beaches

adults N = 3,636 swam, 2,738 waded, 2,212 not in water for ocean beaches
N = 2,031 swam, 470 waded, 440 not in water for lake beaches

TABLE 10-7: HIGHLY CREDIBLE GASTROINTESTINAL SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY SWIMMING STATUS, BEACH TYPE, AND AGE GROUP
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Group	HCGI Rate Children	HCGI Rate Adults	Child vs. Adult Rate Ratio	95% Confidence interval
<u>Ocean</u>				
Swam	34.1	15.1	2.3 *	1.6 - 3.3
Waded	19.8	9.5	2.1 *	1.2 - 3.9
Not in water	17.1	7.2	2.4	1.0 - 6.0
<u>Lake</u>				
Swam	54.4	14.3	3.9 *	2.7 - 5.9
Waded	31.3	8.5	3.8 *	1.2 - 12.3
Not in water	13.5	13.8	1.0	0.1 - 10.2

* p value (two-tailed) < 0.05

HCGI = highly credible gastrointestinal illness symptoms

children N = 1,553 swam, 958 waded, 350 not in water for ocean beaches
N = 1,435 swam, 192 waded, 74 not in water for lake beaches

adults N = 3,636 swam, 2,738 waded, 2,212 not in water for ocean beaches
N = 2,031 swam, 470 waded, 440 not in water for lake beaches

TABLE 10-8: HIGHLY CREDIBLE GASTROINTESTINAL SYMPTOM RATES PER 1,000 STUDY PARTICIPANTS BY BEACH TYPE, AGE GROUP, AND SWIMMING STATUS
New Jersey Ocean Health Study, NJDOH
(data collection 6/18/88 to 9/3/88)

Group	HCGI Rate		Swam vs. not in water rate ratio	95% Confidence interval
	Swam	Not in water		
Ocean				
Children	34.1	17.1	2.0	0.9 - 4.6
Adults	15.1	7.2	2.1 *	1.2 - 3.6
Lake				
Children	54.4	13.5	4.2	0.7 - 26.0
Adults	14.3	13.8	1.1	0.5 - 2.2

* p value (two-tailed) < 0.05

HCGI = highly credible gastrointestinal illness symptoms

children N = 1,553 swam, 350 not in water for ocean beaches
N = 1,435 swam, 74 not in water for lake beaches

adults N = 3,636 swam, 2,212 not in water for ocean beaches
N = 2,031 swam, 440 not in water for lake beaches

11. PUBLIC HEALTH PERSPECTIVES

Due to concerns raised during the pilot study in 1987, NJDOH staff made several efforts in 1988 to address public health issues related to travel and vacation behaviors that might increase the risk of transmitting gastroenteritis. These activities included a telephone reporting system, on-site inspections, and field observations.

Telephone calls received by the NJDOH covered a wide variety of illnesses associated with both saltwater and freshwater swimming. Ten callers reported illness associated with ocean swimming, one caller reported illness associated with bay swimming and six callers reported illness associated with lake swimming. A NJDOH physician identified only one of these calls as an illness likely to be associated with swimming exposure.

Licensed sanitarians from the NJDOH's Community Health Services conducted inspections of selected food establishments and public restrooms at the study interviewing sites. A total of 38 restaurants inspected at coastal beaches did not have levels of noncompliance which would differ from the expected results of inspections of similar food establishments on a statewide basis. A total of 56 restrooms were inspected. Focusing on the issues of high public health concerns, only 36% supplied soap or other hand cleanser and 14% provided hot or tempered water at the sinks for hand washing. These conditions are of public health concern because of direct public use and because of the possibility that some of these public restrooms are being used by employees of nearby food establishments.

In the course of the summer, various investigators working on the study substantiated the observations in 1987 that basic hygiene is not always followed during vacations. Several public beaches had no or poorly accessible public toilets. Children in diapers were seen in swimming areas. Picnic foods were brought on the beach without means for refrigeration.

12. DISCUSSION

12.1 Water Quality Monitoring

Water quality monitoring results from the Ocean Health Study, as well as from both routine monitoring programs and special studies, continue to show that the ocean water quality is generally very good. The indicator organisms for viral infectious agents did not suggest general ocean contamination. The episode of a probable malfunction at a STP in 1988 confirmed the ability of indicator tests, in particular the phage assay, to detect fecal contamination when it is present. The absence of phage levels at swimming beaches during the summer, except during that episode, suggested that STP discharges are not affecting swimming beaches.

12.2 Epidemiology

As has been stated previously, most people are exposed to many infectious sources and that potential sources are present at increased levels within the vacationing population. The study demonstrated that most people do have multiple exposures to potential infectious sources while vacationing, probably increasing risks of contracting illnesses as compared to staying at home.

Illness among families coming to the shore was on the order of 5%, representing a potential source of contagion. Transmission of infectious agents from one individual to another could occur in crowded boardwalk situations or through the swimming water itself. The increased contact with crowds, reduced ability to control food quality, and addition of new activities inevitably results in some cases of infectious disease transmission. Higher rates of infectious illnesses as a result of vacationing may be difficult to avoid.

Various symptoms were elevated among swimmers, but HCGI was the only one predicted to occur from sewage-contaminated water. Symptoms such as ear or throat infections are more likely to result from transmission between individuals than from diluted sewage. The pattern of highest symptom rates among swimmers was seen for ocean beaches as compared to lake beaches and comparison ocean beaches, suggesting that the activity of swimming rather than water quality is the risk factor.

The study identified higher risks for developing HCGI among children, visitors at lakes, and swimmers. Higher rates of acute infectious illnesses were expected among children when the study was designed because there is a tendency for children to pay less attention to hygiene, to have close contact with other individuals, and to have lower resistance. Also as expected, swimmers had a higher risk of HCGI. The higher HCGI rates seen in lake visitors, contrasted to ocean visitors, had not been predicted. There were pronounced differences in the density of swimmers and the demographic characteristics of those at the lakes which offer a more likely explanation for this finding than does water quality.

The good water quality seen during the course of the summer indicated that contamination of ocean beaches from sewage did not occur. This narrow range of water quality made further analysis difficult, since no swimmers were highly exposed to contaminated water.

In epidemiological terms, the risks identified for swimmers are low, with increases in risk of two to three times that of the nonswimmers. The illness rates for swimmers represent cumulative risks including background, travel-related, swimming-related, and bather-related risks and any effect of contamination. Person-to-person transmission of infectious agents can occur readily with swimming. It is likely that the risk for acquiring infection is small, if any, from inherent water quality.

12.3 Peer Review

In order to enhance the quality of the final report, a peer review was undertaken. Candidates were nominated and selected by members of the Science Advisory Group. Five individuals from academic and governmental institutions participated in a review of the interim summary report and the draft final report. They submitted a letter to the NJDOH with their evaluation of the study design and methodology (Appendix E).

12.4 Public Health

The telephone reporting system, on-site inspections, and field observations all suggest that a number of situations present at the beach are not in concordance with general public health recommendations. Hand washing before eating, separating fecal materials from swimming water, and maintaining proper food temperatures are fundamental hygienic standards that have been developed precisely to reduce illness transmission. The lack of sanitary toilet facilities, poor food handling by both families and food establishments, and defecating in the ocean create situations where hygienic conditions are not maintained.

Although any single instance of poor hygiene may not necessarily result in transmission of infectious agents, behaviors such as these will eventually cause such transmission and gastrointestinal illness. While vacations are intended as periods of relaxation, a simultaneous relaxing of sanitary standards is not appropriate. If standards of cleanliness are reduced during a vacation, a certain increase in infectious disease rates can be expected. The illnesses are likely to be mild respiratory and gastrointestinal infections, more common among children and among those in contact with crowds, including increased contact through swimming. Some efforts could be made to reduce the risks for illness transmission. These would include keeping ill household members at home, paying close attention to food handling, and maintaining normal standards of hygiene.

12.5 Goals, Objectives, and 1987 Recommendations

The NJDOH completed the planned epidemiological study. There was not sufficient water contamination to analyze illness rates according to indicator levels. The NJDEP, in conjunction with local agencies, has undertaken a number of efforts to maintain and protect coastal water quality.

12.6 General Comments

A number of misconceptions seem to exist regarding ocean water quality. Except for isolated instances, there has been no evidence of major ocean contamination from the sewage treatment plants. Stormwater drainage, which has little if any risk for illness transmission, is strongly implicated in occasional microbiological contamination of swimming beaches.

Even if sewage contamination of swimming water did occur, the only illnesses expected would be gastrointestinal infections. Illnesses such as Strep throat, conjunctivitis ("pink eye"), "colds", and ear infections are not expected to be transmissible by sewage contaminated water, while they are readily transmitted through close contact, whether in a swimming area (including a chlorinated pool) or in a day-care center. Severe illnesses such as AIDS and hepatitis are not considered transmissible through swimming.

Certain groups, such as children and those swimming in groups, are at increased risk of contracting mild infectious illnesses from other individuals. These risks, while small, are increased during vacation when individuals have contact with many more individuals than typically occurs at home. Like many recreational activities, swimming carries a small risk.

13 RECOMMENDATIONS

Neither elevated risk of illness related to water quality nor high levels of ocean water microbiological contamination were identified in the course of this study.

Based on the study results and the events of 1988, the NJDOH makes three recommendations:

1. The NJDOH should conduct continued swimming-related illness surveillance with the health care community. This includes:
   * telephone consultations
   * outbreak investigations as needed

2. The NJDEP should review the environmental data presented here and determine what, if any, environmental issues remain to be addressed.

3. A coordinated approach to coastal water quality should be considered by state and local officials to address the many facets of coastal protection including development, control of microbiological contamination sources, water quality monitoring, beach facilities, waste disposal, and public education.

14 REFERENCES

Cabelli VJ, et. al. Relationship of Microbial Indicators to Health Effects at Marine Beaches. Am Journal Public Health 69:609-696, 1979.

Monto AS, et. al. The Tecumseh Study, XII. Enteric Agents in the Community, 1976-1981. Journal Infect Dis 148:284-291, 1983.

Seyfried PL, et. al. Prospective Study of Swimming-Related Illness. Am Journal Public Health 75:1068-1075, 1985.

United States Environmental Protection Agency. Health Effects Criteria for Marine Recreational Waters. 1983. Health Effects Research Laboratory, Office of Research and Development.

15 GLOSSARY OF TERMS FOR THE OCEAN HEALTH STUDY

AGENT: a biological, chemical or physical substance capable of causing illness

ASSAY: a test to determine the presence or level of an organism

BACKGROUND RATE: the average or typical amount of disease present at all times in a population

BACTERIOPHAGE: a virus that infects or kills a bacterial cell

BATHER DENSITY: the number of people in a swimming area measured in a uniform manner

CLOSTRIDIUM PERFRINGENS: a bacterium which is found in soil, freshwater, oceans, and the intestines of humans and some animals

COLIFORM: referring to _E. coli_ and related bacteria

EPIDEMIOLOGY: the study of the distribution and causes of diseases in human populations

ENTEROCOCCI: a group of Streptococci bacteria normally found in the intestines of humans and some animals

ESCHERICHIA COLI: (_E. COLI_) a bacterium normally found in the intestines humans and some animals

F2 MALE SPECIFIC BACTERIOPHAGE: a specific type of bacteriophage which infects _E. coli_

FECAL: pertaining to excrement discharged from the intestines, consisting of food residues, bacteria, intestinal cells, and liver and other secretions

FLORA: the bacteria normally found in or on an organism, for example in the intestines or on the skin

GASTROENTERITIS: "stomach flu", an intestinal infection with a viral or bacterial agent characterized by nausea, diarrhea, abdominal pain, and fever

GEOMETRIC MEAN: one of several ways of determining the mean, or average, of a series of numbers. The geometric mean is considered to be one of the most accurate averages for environmental samples of microbiological organisms

INDICATOR ORGANISM: a biological organism used as a measure of fecal contamination

INFECTIOUS:	referring to microorganisms capable of causing illness
MICROBIOLOGICAL	pertaining to a microorganism, such as a bacterium or virus
MUCOUS MEMBRANE:	the thin layer of cells lining the mouth, nose, throat, stomach and other body parts and organs
PATHOGEN:	illness-causing organism
RISK:	a probability that an event (illness) will occur, often within a stated period of time
RISK FACTOR:	an exposure that is associated with an increased probability of a specified outcome (illness)
SPORE:	a resting stage that certain bacteria go through, during which the bacteria are difficult to destroy
STREPTOCOCCI:	a group of bacteria, some of which are normally found in the intestines of humans and some animals
SUSCEPTIBILITY:	the degree to which a person may be affected by an illness-causing agent, reflecting the overall health of the person, the person's immunity to disease, the type of agent, and other factors