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Regional BEACH Program Conferences—1999

Proceedings

Abstract

The goal of the U.S. Environmental Protection Agency's Beaches Environmental Assessment, Closure and Health (BEACH) Program is to significantly reduce the risk of disease to users of the nation's recreational waters through improvements in recreational water programs, communication, and scientific advances. The BEACH Program applies to freshwater recreational areas such as lakes, ponds, and rivers, as well as marine waters like oceans and bays, as does the *Beach Action Plan.*

The *Beach Action Plan* is a dynamic, multiyear strategy governing all EPA activities protecting the public's health from pathogens in recreational waters. One of the objectives listed in the *Beach Action Plan* is for EPA to arrange a series of technical conferences intended for state and local recreational water quality managers. EPA hosted two regional beach conferences, one in San Diego, California, August 31-September 1, 1999, and the second in Tampa, Florida, October 18-19, 1999, to emphasize regional issues and implementation of national guidance.

The conferences provided a forum for learning about beach health initiatives across the country, identified unaddressed beach health needs, assigned priorities to short-term and long-term actions, and recommended protocols and procedures to encourage greater consistency among jurisdictions. The conference was organized into the following sessions:

Session One	Water Quality Standards, Indicators, and Implementation
Session Two	Risk Assessment, Exposure, and Health Effects
Session Three	Monitoring and Modeling
Session Four	Beach Advisories, Closures, and Risk Communication

Each session consisted of individual presentations and a discussion period with questions and comments from the audience and responses by the speakers. This proceedings document contains a summary of each speaker's presentation, a selection of key graphics, summaries of audience questions and responses, and summaries of the breakout group discussions from each conference.

Acknowledgments

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The planning workgroup consisted of representatives from EPA Headquarters (Thomas Armitage, Rick Hoffmann, Charles Kovatch, Melissa Melvin, Steve Schaub, and Elizabeth Southerland) and the Regional Offices (Matt Liebman, Helen Grebe, Joel Hansel, Fred Kopfler, Al Dufour, Holly Wirick, Mike Schaub, Jake Joyce, Janet Hashimoto, Cat Kuhlman, and Phil Woods). The contributions of these persons in planning the conferences are greatly appreciated.

The contributions of the invited speakers and attendees during breakout sessions are gratefully acknowledged. The efforts of these people were critical to the success of the conferences. The material in this document has been subjected to Agency technical and policy review and approved for publication as an EPA report. The views expressed by individual authors, however, are their own and do not necessarily reflect those of EPA. Mention of trade names, products, or services does not convey, and should not be interpreted as conveying, official EPA approval, endorsement, or recommendation.

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West Coast Regional Beach Conference

August 31 and September 1, 1999

San Diego, California

Proceedings

West Coast Conference Agenda

Goals: To provide a forum for all levels of beach water quality managers and public health officials to share information and provide input on the future directions of EPA's BEACH Programs.

Objectives:
1) Present EPA's BEACH Program.
2) Present the state of the science.
3) Discuss local and regional water quality management issues through case study presentations.
4) Obtain feedback on major topic areas for EPA's Beach Guidance document.

Tuesday, August 31–Day 1

8:30-9:30 **Registration**

9:30-9:45 **Welcome**
Felicia Marcus, Administrator
USEPA Region 9

9:45-10:30 **EPA's Beach Plan**
Jim Hanlon, Deputy Director
USEPA, Office of Science and Technology

10:30-12:30 ***Session 1: Water Quality Standards, Indicators, and Implementation***

10:30-10:50 **Overview of Water Quality Indicator Microbes**
Jake Joyce
USEPA, Region 7

10:50-11:00 **BREAK**

11:00-11:20 **New Indicators of Water Quality for Recreational Water Use**
Steve Schaub
USEPA, Office of Science and Technology

11:20-12:00 **State-of-the-Art of Indicator Research: RT-PCR as a Method for Detection of Human Enteric Virus in Coastal Seawater**
Rachel Noble
Univ. of Southern California & Southern California Coastal Water Research Project

12:00-12:30 **Q & A/Discussions**

12:30-1:30 **LUNCH**

1:30-3:30 ***Session 2: Risk Assessment, Exposure, and Health Effects***

1:30-2:00 **The Relationship of Microbial Measurement of Beach Water Quality to Human Health**
Al Dufour
USEPA, National Environmental Research Laboratory

2:00-2:20 **Qualitative Review of Epidemiology Studies**
David Gray
Massachusetts DEP

2:20-2:40 **Pathogen Risk Assessment Methods**
Steve Schaub
USEPA, Office of Science and Technology

2:40-3:20 **Q & A/Discussions**

3:20-3:30 **BREAK**

3:30-5:30 ***Session 3: Monitoring and Modeling***

3:30-3:50 **New Jersey's Recreational Monitoring Program**
David Rosenblatt
New Jersey DEP

3:50-4:10 **Monitoring Program at Lake Powell**
Mark Anderson
Aquatic Ecologist, Glen Canyon National Recreational Area

4:10-4:30 **California's Regulation & Guidance for Beaches & Recreational Waters**
Steven Book
California State DOH, Drinking Water Technical Programs Branch

4:30-4:50 **Southern California Bight 1998 Regional Monitoring Program**
Charles McGee
Orange County, CA, Sanitation District

4:50-5:30 **Q & A/Discussions**

Wednesday, September 1–Day 2

9:00-9:20	**NRDC's Testing the Waters, 1999** David Beckman, Senior Attorney NRDC, Los Angeles Office
9:20-11:20	***Session 4: Beach Advisories, Closures, and Risk Communication***
9:20-9:40	**Communicating About Risk** Sharon Dunwoody University of Wisconsin, Department of Communication
9:40-9:50	**BREAK**
9:50-10:10	**The Aftermath of the Santa Monica Bay Epidemiology Study** Mark Gold Heal the Bay
10:10-10:30	**Beach Advisories and Closures** Chris Gonaver San Diego County Health Department
10:30-11:10	**Q &A/Discussions**
11:10-11:20	**Organization of Breakout Groups** Purpose: Discuss the major components of the Beach Guidance. Provide recommendations and key elements to be included in the document.
11:20-12:30	**BREAKOUT SESSIONS CONVENE**
12:30-1:30	**LUNCH**
1:30-3:30	**BREAKOUT SESSIONS CONTINUE**
3:30-4:15	**Feedback to Plenary from Breakout Sessions**
4:15-5:15	**Open Discussion and Information Synthesis**
5:15-5:30	**Closing Remarks and Adjourn** Jim Hanlon, Deputy Director USEPA, Office of Science and Technology

Welcome

Felicia Marcus
US Environmental Protection Agency, Region 9

Ms. Marcus welcomed the group and noted that many water quality regulators from all levels of government, public health leaders, researchers, facility managers, and water quality activists were in attendance. She commented on the change in the discussions about beach water quality, which are now focused on what are the best and quickest indicators rather than whether sampling should be done at all. She noted that the consciousness has changed on the part of many people—local, state, and federal offices—and beach safety is now a main focus. A case of the stomach flu or an eye infection is a problem even though it may not compare in scale to some of the other issues health departments have to deal with.

She also noted that the discussion has changed to what is the best way to monitor, what are the best indicators, how do we best get this information to the public, how do we close beaches based on circumstances that we know are likely to cause a problem versus waiting for 48 hours until we have proof, after people have been at the beach for two days. Discussions now focus on how to get this information to the public reliably and quickly. It is no longer left to regulators to decide behind closed doors whether to close a beach. Instead, the public has an opportunity to know and to make their own informed choices as part of the whole right-to-know movement. Over the last 10 years there have been changes in the way we find out about sewage spills. To find out about spills, regulators once had to file a Freedom of Information Act Request or a Public Records Act Request. The next advancement required regulators to have a beeper that went off whenever there was a sewage spill and then they issued a press release. Now information is available on the Web in real time so that the public can make their own choices about whether they want to go to the beach.

The players have also changed, not in terms of who they are, but in terms of how they are behaving. There is more work toward building consensus and working together to solve these problems. The time has come politically to solve beach problems. Last year at the President's Ocean Conference in Monterey, there were a tremendous number of announcements about the EPA BEACH Program, although they were overshadowed by offshore drilling and other fish issues. The Bilbray bill is moving through Congress as well. Things have moved even faster at the state level, with the passage of the Howard Wayne bill in California 2 years ago leading the way in the nation. It has resulted in a lot more beach closures in California. Many of Southern California partners inside and outside government are developing a Web site that will give public access to information as to whether a particular beach is safe for swimming that day. The Southern California pilot should be completed shortly and then move up the coast before leaping the Pacific to Hawaii.

The TMDL effort, storm water regulations, and other initiatives are being brought together into preventive solutions to the other end of the problem. There are renewed efforts on combined sewer overflows and sanitary sewer overflows to deal with the sewage issue. EPA has a regulatory role in ensuring that states adopt protective standards and that discharges to beaches meet water quality goals, and strong water programs play a major role in keeping the beaches clean. TMDLs are the next wave and finally give us a shot at integrating point and nonpoint sources in an intelligent way over a given geographic surface leading into a particular waterbody.

In addition to the regulatory side, one of the most important roles of EPA is to help provide good science to help set the standards for pathogens and for monitoring them. EPA also has the ability and responsibility to convene interested parties to share information not only on the science but also on how beach safety is communicated to the public. These nonregulatory pieces of EPA's job are the reason for this conference and the reason the Agency is so pleased that so many people could attend. Finally, EPA has put forth an ambitious Action Plan, which Jim Hanlon will discuss in detail, and hopes to get feedback on it from the participants.

EPA's Beach Plan

Jim Hanlon
US Environmental Protection Agency, Office of Science and Technology

Jim Hanlon presented background on where EPA is and has come from, and the EPA Beach Action Plan for beaches and recreational waters, and he offered an outline of where that will lead EPA in the future. The conference, he noted, would provide a forum for beach water quality managers and public health officials to share information and to provide input to EPA that will assist in development of the Agency's program to protect the public from microbial pathogens in recreational waters. EPA's objectives for the conference included sharing information and gaining feedback on the development of national guidance. The conference would present ongoing and planned recreational water program activities and describe the current "state of science" in recreational water standards, disease indicators, risk assessment, monitoring, and risk communication. At the breakout sessions state, local, and federal officials would discuss issues related to the guidance in order to enable national consistency in managing beach water quality. The text of Mr. Hanlon's comments follows.

In May 1997, Administrator Carol Browner announced the establishment of the BEACH (Beaches Environmental Assessment, Closure and Health) Program in response to concerns about water quality in recreational areas. Persistent water quality problems (evidenced by advisories and closings), inconsistencies in monitoring between states, inconsistent public notification programs, growing concerns about microbial contaminants, and increased pollution pressures all led to the development of the BEACH Program.

In 1997, the Natural Resources Defense Council's 8th annual survey on beach water quality reported at least 4,153 days of beach closings and advisories caused by pollution. EPA's annual National Health Protection Survey of Beaches, completed in 1998 and 1999, indicates that many beaches continue to have water quality problems. In 1999, EPA gathered information from more than 1,400 beaches, and approximately 25 percent of the beaches were associated with at least one advisory or closing in the 1998 beach season. The surveys were issued to agencies responsible for coastal beaches, including the Great Lakes. Future efforts will increase the scope to capture inland beaches.

Results of the survey confirmed that a wide variety of standards and monitoring approaches are used at beaches throughout the United States. There is no published technical guidance that deals with protocols for monitoring, depth to sample, intervals for sampling, and so forth. EPA surveys have indicated that because of varying resources and diverse local circumstances, the local agencies (county health departments and sanitation districts) responsible for notifying the public of water quality problems use a wide range of risk communication practices. There is a great need to communicate more effectively with the public.

There is growing concern about microbiological contamination. There is now recognition that recreational water users are at risk of infection from waterborne pathogens through ingestion or inhalation of contaminated water or through contact with the water. Some people may face a disproportionate risk from exposure to the pathogens because of heightened susceptibility. For example, children may be more vulnerable to environmental exposure because of their active behavior and developing immune systems.

Most of the recreational water quality problems are man-made. More than 50 percent of the U.S. population live within 50 miles of the coast, where people are densely packed into less than 10 percent of the nation's land. Serious overcrowding in the highly popular coastal locations, especially in the Northeast, mid-Atlantic region, and Southern California, has already caused water quality problems, and demographers project continued increases in the years ahead. EPA's reaction has been to establish open dialogue with local beach managers. To address these problems, EPA has organized a number of beach conferences. The First National Beach Conference was held in October 1997 in Annapolis, Maryland. The purpose of that conference was to identify important issues that must be addressed by EPA's BEACH Program. Now, with these regional conferences, EPA wants to focus on specific topics and concerns and has invited representatives of state, local, and regional organizations to participate.

In March 1999, EPA published the Agency's *Action Plan for Beaches and Recreational Waters*, which was derived from the 1997 conference. The Beach Action Plan identifies EPA's multiyear strategy for monitoring recreational water quality and communicating public health risks associated with potentially pathogen-contaminated recreational rivers, lakes, and ocean beaches. An important part of this strategy is to improve and assist in state, tribal, and local implementation of monitoring and public notification programs.

The plan strengthens and supports state and local programs. Most of the programs are centrally managed through compliance and monitoring. EPA will strengthen water quality standards implementation programs by establishing appropriate policies (e.g., what should be done in tropical waters) and assisting local managers in their transition to EPA's currently recommended Ambient Water Quality Criteria for Bacteria.

Guidance and technology transfer are key components of the beach program. EPA will coordinate the planning and issuance of national BEACH Program guidance documents addressing recreational water quality monitoring, risk assessment, risk management, and risk communication, incorporating input from state and local participants. This conference will assist us in developing the guidance.

National beach health survey and public right-to-know communication efforts will also be an important part of the guidance development. EPA will continue to conduct an annual national beach health survey to collect detailed national data on state and local beach monitoring efforts, applicable standards, beach water quality communication methods, the nature and extent of beach contamination problems, and any protection activities. Surveys have been completed during each of the past 2 years, and the results have been made available to the public on EPA's Beach Watch Internet Web site. EPA will continue to maintain this web site to provide timely recreational water quality information to the public and to local authorities. The current Web site will become a real-time electronic database with links to state and local beach health-related information. The Web site will also provide information identifying those beaches where monitoring and assessment activities are conducted in a manner consistent with EPA's national guidance.

An important part of EPA's effort to make beach information available to the public is to develop a national digitized inventory of beach maps. EPA will develop a protocol for mapping beaches and begin mapping in priority areas. These maps will ultimately be linked to the location of pollution sources through a geographic information system. This will help beach managers visualize the resource and potential threats.

EPA has recognized the need for developing better and faster indicators of water quality. Indicators are needed to identify risk before exposure takes place and to determine the potential presence of pathogens causing nonenteric diseases. Work has begun to complete research to reduce sample processing and development of new indicators.

A number of mathematical models have been or are being developed to assess the migration of pollution near recreational waters. These models can be used to rapidly determine public health risks at beaches following rainfall events or spills. EPA has catalogued a range of predictive tools and is improving them. A catalogue and evaluation of existing models is available on EPA's Beach Watch Web site. Models range from rules of thumb for predicting risk, such as the occurrence of intense rainfall, to complex hydrodynamic models.

Research is planned to investigate the risks of combined sewer overflows, the role that interstitial waters play in microbial exposure to bathers (particularly children), and human exposure factors (such as inhalation, skin contact, time spent in the water, skin abrasions or cuts, and crowding of swimmers at small recreational areas) that contribute to adverse health effects. EPA has identified a need for epidemiological studies to establish a link between water quality indicators and disease endpoints. New and innovative indicator methods will be used to assess and validate their efficiency for determining health risks.

EPA beach-related activities have taken greater prominence because Beach Program legislation has been proposed in the U.S. Congress. The House of Representatives passed H.R. 999, the Beach Environmental Awareness, Cleanup and Health Act, sponsored by Congressman Bilbray, on Earth Day. Senator Chafee chaired a Senate hearing on July 22 on two beach bills, Senator Lautenberg's bill (S. 522) and H.R. 999. There has been no action yet on these bills in the Senate, but they are being reviewed and a vote on them may be taken in this session of Congress.

It is hoped that there will be more action on these bills in the fall. The proposed legislation would require the adoption of revised state water quality standards consistent with EPA's current ambient criteria for bacteria (i.e., *E. coli* or enterococcus) within 3.5 years. The legislation would establish state or local beach monitoring and notification programs. EPA grants to states and local governments would support monitoring and notification programs.

The legislation would provide for an increased federal role in developing standards for consistent monitoring and in monitoring where state and local governments fail to act. The legislation tasks EPA with the responsibility for developing federal guidance and regulations for monitoring and notification. EPA will develop a national public right-to-know database with access to local beach data. The agency would also conduct monitoring and notification if it is not done by state and local governments. EPA will have to balance the requirement for national consistency in monitoring and notification with the need for flexibility to address site-specific conditions.

Session One: Water Quality Standards, Indicators, and Implementation

Overview of Water Quality Indicator Microbes

Jake Joyce
US Environmental Protection Agency, Region 7

An indicator is a parameter or a value derived from a parameter which provides information about the environment with a significance extending beyond that which was measured, and is intended as a surrogate for other unmeasured parameters. Indicator microorganisms are used to conduct microbiological examinations of water in order to determine its sanitary quality. Indicator organisms are used in drinking water, shellfish sanitation problems and in recreational waters, which is the topic of this presentation. Although waterborne disease can be caused by viruses, protozoans, bacteria or helminthes, only bacterial indicators are used to assess water quality. This is because routine examination of water for pathogenic microorganisms is not recommended, except for special studies, or for the examination of water-related illness, and then, only certain pathogens are sought. In other words, the levels of indicator microorganisms are measured in lieu of looking directly for a large suite of pathogenic microorganisms. A human fecal sample can contain as many as a hundred different species of bacteria. The primary function of a water pollution indicator organism is to provide evidence of recent fecal contamination from warm-blooded animals. A proper indicator of fecal pollution should survive longer, but not much longer than the intestinal pathogens it is intended to indicate. In other words, if it doesn't survive as long as a pathogen, then a false negative could result. If it survives appreciably longer than the pathogens, it could indicate false positive results.

The concept of an indicator assumes that the indicator bacteria are randomly dispersed in the water body. In reality this is seldom, if ever, the case. Another major limitation with bacterial indicators is that they are based upon gastrointestinal disease alone, while inhalation and contact diseases can result from exposure to the contaminated water. The use of an indicator is limited because a relatively small volume sample is used to represent a much larger quantity of water. Also, any indicator chosen is a surrogate for disease-causing pathogens.

The currently used bacterial indicators for the presence of fecal contamination are as follows:

1. Total coliforms—includes several genera of gram(-), facultative anaerobic, non-spore- forming rod-shaped bacteria, some of which occur in the intestinal tracts of animals and humans, and some of which occur naturally in soil and in fresh or marine waters. The coliform group is made up of a number of bacteria including genera of *Klebsiella, Citrobacter, Ecsherichia, Serratia,* and *Enterobacteria.* Although the total coliforms test was essentially a surrogate for *E. coli*, it is the false positives from this traditional water quality test which have prompted the adoption of more definitive indicators of water pollution by fecal matter. The total coliform test was used an indicator until 1968 when the Federal Water Pollution Control Administration recommended that a subgroup of the total coliforms (the fecal coliforms) be adopted.

2. Fecal coliforms—includes several species of coliform bacteria that are able to ferment lactose and produce gas, and they commonly occur in the feces of warm-blooded animals. The fecal coliform (or "elevated temperature" test) was developed in 1904 to screen for *E. coli*. The use of the term "fecal coliforms" has proven to be a poor choice,

however, because it implies that all microorganisms responding to the test come from fecal matter, which is an incorrect assumption. In theory, the 44.5 °C temperature should inhibit the growth of Citrobacteria and Enterobacters, but many members of the *Klebsiella* group are thermotolerant and can survive. More alarming was the discovery that some strains of *E. coli* could be inhibited by the elevated temperatures, leading to false positive results. The fecal coliform indicator has been used to measure water quality and has been faulted because non-fecal environmental sources of *Klebsiella, Citrobacter* and *Enterobacteria* bacteria have been noted. This could have the effect of causing a false positive or a false negative in the water sample for sewage contamination. This lack of specificity for accurately differentiating between fecal and non-fecal contamination also compromises the value of the fecal coliform method for assessing water quality. Also, the fecal coliform method does not differentiate between fecal organisms of human or animal origin. The standard for fecal coliforms is the logarithmic mean of five samples taken over a 30-day period should not exceed 200 fecal coliforms per 100 mL of water. In addition, 10 percent of the total samples during any 30-day period should not exceed 400 fecal coliforms per 100 mL of water.

Note: Studies have indicated that fecal and total coliform counts do not correlate well with levels of pathogenic bacteria and viruses actually measured in waters. To account for this, two new tests were proposed for determining fecal contamination in waters in 1986:

3. Enterococci—round coccoid bacteria that live in the intestinal tract. *Streptococcus faecalis* and *S. feacium* are two indicators of that group that are more human-specific than the other members of the group, but can be isolated from the intestinal tract of domestic animals. These two microorganisms were chosen because they are the main detected bacteria from this test. For enterococci, the freshwater standard is the geometric mean of the bacterial densities of five samples taken over a 30-day period which should not exceed 33/100 mL. The marine water value should not exceed 35/100 mL. The single sample maximum is 61/100 mL for freshwater and 104/100 mL for marine water.

4. *Escherichia coli*—a member of the coliform group whose presence indicates fecal contamination since it is one of the ubiquitous coliform members of the intestinal microflora of warm-blooded animals. Under its previous name, *Bacterium coli*, it has been recommended as an indicator of fecal pollution in waters since 1904, but its use was delayed until a method specific to its enumeration was developed. In the late 1980s scientific evidence was amassing that *E. coli* itself should be the bacterial indicator for fecal contamination in waters. *E. coli* has been found to be universally present in the fecal matter of warm-blooded animals at densities from 10^8 to 10^9 per gram and comprises nearly 95 percent of the coliforms in feces. This indicates that *E. coli* would always be present in fecal contamination incidents whereas the other members of the coliform group may or may not be present, even though known sewage contamination was present. The steady-state geometric mean indicator density (five samples equally spaced over a 30-day period) is 126 *E. coli* per 100 mL water.

As a final note, along with sampling and analytical difficulties, perhaps the greatest problem with the use of indicator data is people who are unaware of the limitations of the tests and interpret them inappropriately. Finally, indicator microbe analytical data should not be interpreted alone. It should always be used in conjunction with a sanitary survey; however, this step is often omitted.

WATER CONTAMINATION INDICATORS

Jerome (Jake) Joyce, Ph.D.

Indicator—a parameter, or a value derived from a parameter, which provides information about the environment with a significance extending beyond that which was measured, and is intended as a surrogate for other unmeasured parameters.

Indicator organisms are used to conduct microbiological examinations of water in order to determine its sanitary quality.

Indicator organisms are used for determining fecal contamination in:

- drinking water
- recreational waters
- shellfish sanitation

An ideal indicator organism should:

- be found only when pollution or pathogens are present
- be absent when pollution or pathogens are present
- occur in larger numbers than the pathogens
- increase in numbers in proportion to the degree of pollution

An ideal indicator organism should (cont):

- respond to routine testing procedures
- survive longer that the pathogens
- be applicable to multiple sanitary situations
- have consistent culture characteristics

Although waterborne disease can be caused by viruses, protozoans, bacteria or helminthes, only bacterial indicators are used to assess water quality.

Routine examination of water for pathogenic microorganisms is not recommended except for special studies or for examination of water-related illness, and then only specific pathogens are sought.

In other words, the levels of indicator microorganisms are measured in lieu of looking directly for a large suite of waterborne pathogenic organisms.

A human fecal sample can contain as many as a hundred different species of bacteria.

Human fecal bacteria include:

- (primary species)
  - *Bacteroides*
  - *Lactobacillus*
  - *Escherichia coli*
  - *Enterococcus*

Human fecal bacteria (cont)

- (secondary species)
  - *Citrobacter*
  - *Klebsiella*
  - *Clostridium*
  - *Staphylococcus*
  - *Bacillus*

Human fecal bacteria (cont)

- (rare but can be found)
  - *Proteus*
  - *Providencia*
  - *Pseudomonas*

A number of bacterial species have been proposed as indicators of fecal pollution:

- *Vibrio*
- *Clostridium*
- *Pseudomonas*
- *Bifidobacterium*
- *Bacteroides*
- *Yersinia*

A primary function of a water pollution indicator microorganism is to provide evidence of recent fecal contamination from warm-blooded animals.

A proper indicator of fecal pollution should not survive longer that the intestinal pathogens it is intended to indicate.

The indicator concept assumes that the indicator bacteria are randomly dispersed in the water body. In reality, this is never the case.

A simple cause-and-effect relationship between pollution and human disease is often difficult to substantiate.

Another major limitation with bacterial indicators is that they are based upon gastrointestinal disease alone, while inhalation and contact diseases can also occur from contaminated water.

There is no indicator organism or group of organisms that can predict the transmission of disease by all possible waterborne routes.

Some waterborne pathogens (viruses and protozoans) can survive in water longer than indicator bacteria, leading to false negatives.

The use of an indicator is limited as:

- the relatively small volume sample is used to represent a much larger quantity of water
- any indicator chosen is a surrogate for disease-causing pathogens

The major problem with the total coliform test is the false positive results from naturally occurring microbes.

The total coliform group includes the following *genera*:

- *Klebsiella*—found in feces and natural environment
- Enterobacter—found in feces and natural environment
- *Citrobacter*—found in environmental sources
- Serratia—found in environmental sources
- *Escherichia*—always found in feces

The total coliform test was the standard until 1968 when the Federal Water Pollution Control Administration recommended that a subset of the total coliforms (fecal coliforms) be used instead.

Fecal Coliform Test—originally developed in 1904 to screen for *Bacillus coli* (now called *E. coli*).

The fecal coliform method does not differentiate between fecal organisms of human or animal origin.

The fecal coliform test does distinguish between fecal and nonfecal contamination, but not between human and nonhuman sources.

The major drawback of the fecal coliform test is that *Klebsiella* bacteria, which can be naturally occurring, can survive the elevated temperatures and give false positive results.

A final drawback of the fecal coliform test is that some strains of *E. coli* are unable to ferment lactose or are not thermotolerant; this can lead to false negative results.

In 1986, EPA issued a revision to the ambient water quality criteria to include new bacterial indicators which provide better correlation with gastrointestinal disease than does the previously used fecal coliform test:

- *Escherichia coli*
- Enterococci

Enterococci and *E. coli* are both recommended for fresh recreational waters, while enterococci are preferred for marine waters.

E. coli is an ideal indicator for fecal pollution because it:

- is an obligate parasite of humans and animals
- doesn't multiply out of the host's body
- vastly outnumbers potential waterborne pathogens
- dies off in the environment and indicates recent pollution

For fecal coliforms, the criterion is the geometric mean of 200 fecal coliforms per 100 mL.

For recreational fresh waters, the guideline is 33 enterococci/100 mL water, while for marine waters it is 35/100 mL.

For full contact recreational waters, the geometric mean of the indicated bacterial densities of not less than 5 samples taken over a 30-day period should not exceed one or the other of the following:

- *E. coli* 126 per 100 mL
- Enterococci 33 per 100 mL

Fecal streptococci have generally been found to be more persistent than fecal coliforms in natural waters.

The fecal streptococcus group consists of a number of species of the genus including:

- *S. faecalis*
- *S. faecium*
- *S. avium*
- *S. bovis*
- *S. equinus*
- *S. gallinarum*

The enterococcus group is a subgroup of the fecal streptococci and includes:

- *S. faecalis*
- *S. faecium*
- *S. gallinarum*
- *S. avium*

The fecal streptococci are favored as indicators because:

- consistently present in feces of warm-blooded animals
- survive longer than pathogens in environment
- are not frankly pathogenic
- do not seem to multiply appreciably in polluted waters

Enterococci are round coccoid bacteria that live in the intestinal tract of warm blooded animals.

- *Streptococcus faecalis*
- *Streptococcus faecium*

These two streptococci are used as they are considered more human specific than others which can be found in wild and domestic animals' intestinal tracts.

No assumptions can be made concerning indicator/pathogen ratios; therefore:

- A water with indicators exceeding certain levels may be considered unsafe.
- A water with indicators below certain levels is not necessarily free of risk.

Along with sampling and analytical difficulties, perhaps the greatest problem with the use of indicators is people who are unaware of the limitations of the tests and interpret them in inappropriate ways.

Indicator microbe analytical data should not be interpreted alone. It should invariably be used in conjunction with a thorough sanitary survey; however, this second step is often omitted.

New Microbial Pathogen Indicators for Recreational Water Use

Steve Schaub
US Environmental Protection Agency, Office of Science and Technology

The use of enterococci and *E. coli* for determining the safety of recreational waters was established by EPA in its 1986 recreational water criteria. These indicator organisms were selected after epidemiological studies on recreational exposures demonstrated that they correlated with acute gastrointestinal disease (AGI). The indicators and the associated pathogens that cause AGIs are typically of fecal origin. Recently, a number of new concerns about the sources of indicators, their relationship to other diseases and types of exposures, and their adequacy to provide water quality information in a meaningful time frame have been identified.

There are a number of specific requirements for improvements to the capabilities of indicators used in recreational water monitoring, such as rapid or real time indicator methods to detect fecal contamination; capabilities to discriminate animal vs human fecal contamination; expanded ability to determine the potential for more serious diseases risks than just acute diarrhea; new capabilities to determine risks from skin, ear, eye, and upper respiratory tract infection; and better indicators for use to determine disease risks in tropical waters (current indicators are suspect because of environmental regrowth).

When enhanced or new indicator capabilities are available, it will be important to ensure that they are easy to use, are affordable, and have adequate precision and accuracy to provide results that health professionals and the public will have confidence in. To ensure that the methods will allow risk-based decision making, it is important to demonstrate that they reflect the potential and magnitude of disease risks they have been designed for. However, in the final analysis, the new indicator methods will only be as instructive about health risks as the monitoring programs will allow for assessments of the temporal and spatial variability typically found in recreational waters.

New Indicators of Recreational Water Quality

Stephen A. Schaub
USEPA
Office of Water
Office of Science and Technology

Classical Criteria for Ideal Fecal Contamination Indicators

- Numbers in water are associated with risks of enteric illness to swimmers (a dose-response relationship).
- Survival => than pathogens and stable characteristics.
- Don't regrow environmentally and harmless to humans.

Classical Criteria for Ideal Indicators (cont)

- Apply to all waters and detection/assay is simple and fast.
- Always in fecally contaminated samples when pathogens are present - correlated with degree of fecal contamination.

Problems with Fecal Indicators

- Analyses take too long for many applications and for public health decisions.
- Distribution of indicators and many pathogens becomes divergent once excreted from gut.
  - Different environmental fate and transport
  - Different effectiveness of wastewater treatment and disinfection

Concerns About Indicators (cont)

- Analyses impacted by interference from water matrices.
- Methods don't discriminate fecal sources.

Why Not Direct Pathogen Monitoring?

- Typically costly and sophisticated.
- Too many to monitor, even for multiplex probes and PCR.
- Occurrence in population/wastewaters is sporadic or cyclical.

No Direct Pathogen Monitoring (cont)

- Water constituents interfere with sampling and assay, reducing recovery and reproducibility:
  - turbidity, soluble and colloidal organics, non-target organisms, salts, and extreme pH.
- Low concentrations require large sample volumes -
  - 10 - 1000 L.
- Difficult to determine significance of isolates - detection often mandates knowledge of viability and human infectivity, etc.

Improved Indicator Tools To Meet Future Monitoring Needs

- CRITERIA FOR IMPROVEMENTS:
  - Risk-based: Indicate potential for disease in exposed population.
  - Adaptable to multiple usages/media.
  - Fast, inexpensive, easy to perform and to interpret.

Improved Indicator Tools (cont)

- Allow field analyses.
- High precision and accuracy.
- Accommodate water matrices (interferences).

Recreational Water Indicator Needs

- Real-Time Recreational Indicators:
  - Requirement: rapidly determine potential risks before exposure occurs. 18-48 hr indicators won't prevent exposures.
  - Development approach is "dipstick" or other rapid, easy-to-use, inexpensive technology, e.g., fecal chemicals or microbes.

Real-Time Indicators (cont)

- Representative candidates: caffeine, fecal sterols, detergents, IgA, immunological tests for antigens (elisa).
- Can use frequently at the beach. Positive samples may trigger more sampling, possibly tiered with more sophisticated indicators.

Recreational Water Indicator Needs

Differentiation of Human vs Animal Fecal Contamination:

- Requirement: Track sources of contamination to eliminate them or determine potential for exposures and risk of illness.
  - Domestic/feral animals excrete fecal indicators and pathogens: AFO/CAFO and runoff levels in water may exceed human source indicators.

Differentiation of Fecal Contamination: (cont)

- Representative candidates: DNA fingerprinting, phage typing, PCR/probes fecal chemicals.
- From a public health perspective, are pathogens from animals really less of a concern for swimming if they infect humans?
- Bird or animal droppings can close beach because of resulting high indicator levels.

Recreational Water Indicator Needs

Tropical Water Indicators:

- Requirement: Evidence that coliforms (including *E. coli*) and enterococci can grow in soil/water in tropics. May result in false positive indications of fecal contamination.
- Confirm regrowth and determine essential conditions; also establish the minimum "tropical" temperature and period of growth.

Tropical Water Indicators: (cont)

- Potential candidates: *Clostridium perfringens*, phage, genetic markers of re-growth capability.
- Establish tropical criteria on regrowth factors and ID tropical range that states could use for implementing alternative methods.

Recreational Water Indicator Needs

Indicators of Nonenteric Diseases:

- Requirement: many swimming-associated diseases are not necessarily of fecal origin, e.g., ear, upper respiratory tract, and skin infections. Fecal indicators are not appropriate.
  - Other sewage (grey water), industrial and food wastes contain nonenteric pathogens that swimmers are exposed to.

Indicators of Nonenteric Diseases (cont)

- Potential indicators: *Pseudomonas* spp., *Staphylococcus* spp., fungi, and others.
- Can a single indicator represent risks for all nonenteric diseases and their sources?
- Anthropogenically derived indicators are not suitable for water-based pathogens.

Recreational Water Indicator Needs

Enhanced Methods for Serious Enteric Disease and Sequella:

- Requirement: Some enteric diseases of a severe nature may pose swimming risks, e.g., hepatitis, diabetes, sequella from viral infections, campylobacteriosis. Enterococci and *E. coli* have demonstrated relationship only for AGIs.

Methods for Serious Disease: (cont)

- Potential candidates: ?? What approach would provide relevance to severe diseases having low infectious dose, long incubation time, or sequella?
- Look for novel indicator approaches that correspond to presence and magnitude of these types of disease risks. Could indicators capture the range of diseases of concern considering different sources, infective dose, fate and survival factors?

Recreational Water Indicator Needs

Other Needs:

- Applicability to emerging disease risks.
- Tiered indicator approaches - positive indicator sample triggers additional definitive indicator or pathogen assessments.
- Indicators of poor environmental conditions, e.g., high nutrients (*V. parahemoliticus* and *V. vulnificus*).

Other Needs (cont)

- Establish disease correlations for beaches using sensory approaches: smell, color, sewage debris, dead birds and animals, etc.
- Establish significance of viable, but non-culturable - discount, or resuscitate and count?
- Determine appropriate sample volumes - is 100 mL adequate? What are upper volume limits?

Other Needs (cont)

- Determine method's precision, accuracy, and bias.
- Establish indicator - disease risk relationships for criteria development.

Monitoring Issues for Assessing Water Quality

- Monitoring requirements are naive to dynamic indicator or pathogen loadings (seasonal and event-driven changes).
- Monitoring strategies can detect excess risk - but lack cohesive strategies to determine when water is safe again.

Monitoring Issues (cont)

- Low-frequency monitoring may not adequately determine local spatial/temporal effects:
  - changing hydraulic flows and underwater topography.
  - wind and wave action.
  - sediment dispersal into water column.
  - tides.
  - variable water column distribution, e.g., salinity gradients.

State-of-the-Art Indicator Research: Reverse Transcriptase Polymerase Chain Reaction as a Method for Detection of Human Enteric Viruses in Coastal Seawater

Rachel Noble
Southern California Coastal Water Research Project

Microbial pathogens introduced into the coastal environment, from storm drains, are a major concern for those using the ocean for food and recreation. Questions related to the presence of pathogens in the sea take on particular significance in an area like Southern California where beach-going and marine recreation are very popular and occur year-round. Also, storm drains in Southern California are known contributors of microbial contamination to adjacent beaches and have been demonstrated to adversely affect the health of those using coastal waters for recreation (Haile et al. 1999).

For decades, bacterial indicators have been used to infer microbiological water quality in recreational waters. However, viruses have long been known to be important etiological agents of waterborne disease. Human pathogenic viruses can be found in coastal waters contaminated by urban runoff and sewage, but currently used microbiological standards for recreational waters do not include viruses. Shortcomings in bacteriological water quality standards have been revealed on several occasions where viruses were isolated from seawater that met current standards of bacterial indices. Previous studies indicated that several dangerous viruses can be contracted by swimming or diving in contaminated ocean waters (Cabelli et al. 1982, Seyfried et al. 1985, Haile et al. 1999).

A major goal of this project was to study viral indicators, human enteric viruses, along the coast of southern California, with a focus on storm drains. We were interested in optimizing the methods for detection of human enteric viruses by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) in seawater and learning if the presence of human enteric viruses was related to concentrations of indicator bacteria. Total and fecal coliform, and enterococci were assayed by standard detection methods performed by a state-certified laboratory. Enteroviruses are members of the picornaviridae, a family of single-stranded RNA viruses, including poliovirus, coxsackievirus, echovirus, and other enteroviruses.

For detection of human enteric viruses by RT-PCR, a large-volume seawater sample (20-40 L) was retrieved in ankle-deep waters, concentrated with the use of spiral cartridge and Centriprep-30 centrifugal ultraconcentration units. RT-PCR was performed with the use of pan-enterovirus "universal" primers for total enterovirus nucleic acid amplification.

RT-PCR was successfully used to detect human enteric viruses in coastal seawater samples, and results were attainable within 18 hours. Detection of human enteric viruses was positive in 23 (35%), negative in 35 (54%), and inconclusive in 7 (11%) seawater samples, (n = 65). There was no direct correlation between RT-PCR results and measurable rainfall, but our analyses demonstrated that positive results for human enteric viruses were significantly more likely during the winter "wet" season than during the summer "dry" season. Results of 62 and 56 samples did not demonstrate any overall significant logistical correlation to total and fecal coliforms, respectively ($p > 0.05$). However, a subset of samples analyzed during August 1998 were taken from 15 randomly selected year-round flowing storm drains in the Southern California Bight, and revealed a weak logistical correlation to fecal coliforms. In 73 percent of the samples, the presence of human enteric virus coincided with the exceedance of the fecal coliform threshold of 400 cfu/100 mL. Results of 14 samples taken from within Santa Monica Bay showed a significant, but weak, logistical correlation to levels of enterococci ($R = 0.50, p < 0.05$). Inconclusive results occurred about one-ninth of the time where inhibition of PCR occurred due to substances in the seawater. Optimization of our concentration procedure has improved the RT-PCR method over time and has reduced the incidence of inconclusive results; e.g., during the last two years, only one analysis was inconclusive.

Our results demonstrate that RT-PCR is an effective method for the detection of human enteric virus genomes in coastal seawater, and that viruses from fecal contamination may degrade or decay quite differently than their bacterial counterparts. It is useful to use direct approaches to determine the presence and quantity of human enteric viruses introduced into the marine environment. At this time, there is no strong correlation between the presence of human enteric viruses and routinely monitored coliforms at storm drain locations. Our research demonstrates that virus testing may be advisable at high-use beaches, especially those influenced by storm drains.

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Seyfried, D.L., R.S. Tobin, W.E. Brown, and P.F. Ness. 1985. A prospective study of swimming-related illness. II. Morbidity and the microbiological quality of water. *American Journal of Public Health* 75:1071-1075.

State-of-the-Art Science: RT-PCR as a method for detecting enteroviruses

Rachel T. Noble
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Microbiological Testing of Recreational Waters in the U.S.

Bacterial Indicators

- Are used to infer microbiological water quality as indicators of human fecal contamination
- Indicators are not all pathogens themselves
- Tests are relatively rapid, standardized, inexpensive, and simple to perform
- Currently no standardization between labs, but results show that performance-based approach is acceptable
- Southern California beaches are some of the most extensively monitored in the country

Microbiological Testing of Recreational Waters in the U.S., cont'd

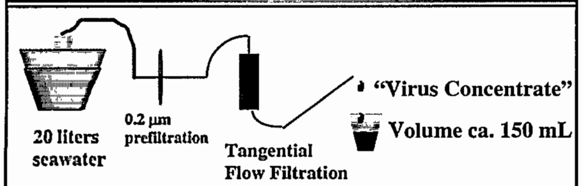
Viral Indicators

- Pathogens in sewage and runoff include viruses
- Viral indicators are direct indicators of pathogens; some of the currently used are enteric viruses, adenoviruses, Hepatitis A virus
- Testing by molecular methods is rapid, but expensive and not yet standardized for routine monitoring purposes
- No water quality standards set for viral indicators

Assays for Viral Indicators

- Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) is used to detect specific virus genes
- Much faster and more sensitive than assays that require cultivating of viruses, and can detect some viruses that culture assays cannot
- Might be more suitable for management decisions
- Caveat: Because it detects the presence of viral genes, not infectivity, positive results could include inactive viruses. Positive results are still probably a reasonable indicator of active viruses

Virus Concentration Protocol



1) Virus concentrate is further concentrated with centrifugal ultraconcentration units

2) Final volume of virus concentrate is 0.1 mL, concentration factor of 200,000 X

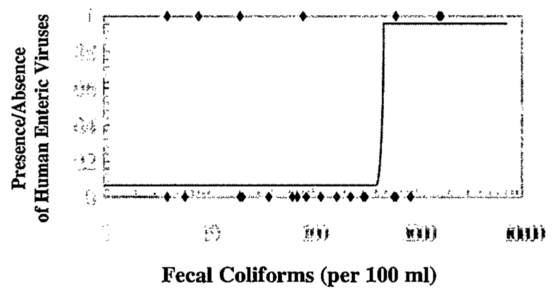
Sampling Locations

- Locations tested are mainly storm drain or high-use sandy beach sites in the Southern California Bight
- More intensive sampling in Santa Monica Bay
- Most sample sites have a routine bacteriological monitoring program associated with them
- Coordination with agencies for routine sampling provides information on bacterial indicators

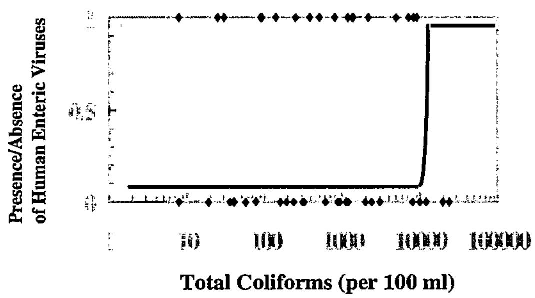
Relation between viral and bacterial indicators?

- Perform RT-PCR for presence/absence of viral indicators: enteroviruses
- With presence/absence values for enteroviruses perform logistical correlation analyses with levels of bacterial indicators
- Logistical correlation based upon bacterial indicator thresholds
- With quantitation of enterovirus genes, analyze rank correlation between bacterial and viral indicators and total viral and bacterial abundance

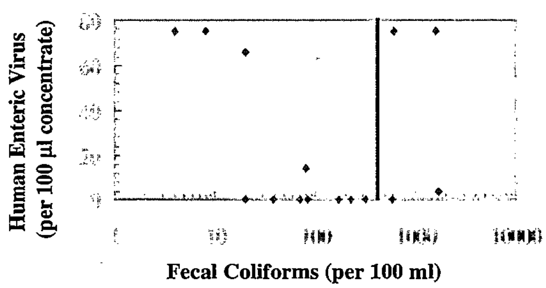
Logistical Regression of Enteroviruses vs. Fecal Coliforms during the Summer Season



Logistical Regression of Enteroviruses vs. Total Coliforms



Fecal Coliforms versus Enterovirus Levels during the Summer Season



Results of RT-PCR Work

- 65 samples analyzed over 5-year period
- Inconclusive results in early tests indicated problems with inhibition of PCR, likely due to humic acids and changing ionic conditions
- Positive results seen at high-use sandy beaches and storm drain locations
- Positive results seen more than 50% of the time after measurable heavy rain (> 0.5 inch)
- Positive results about 50% of the time at storm drains, even during the summer "low flow" periods

Relation between viral and bacterial indicators

- No strong significant logistical correlation between any of the bacterial indicators (total and fecal coliforms, total/fecal coliform ratio, or enterococcus) and the presence of enteroviruses
- Only a weak logistical correlation ($p < 0.1$) between fecal coliforms and enteroviruses during the summer season, weak logistical correlation between enterococcus and enterovirus only in Santa Monica Bay
- No significant rank correlation between bacterial indicator and enterovirus levels at storm drains

Implications for use of viral indicators for water quality testing

- Results demonstrate that virus testing may be necessary under specific circumstances (e.g., at high-use sandy beaches or areas adjacent to flowing storm drains)
- RT-PCR permits detection of specific types of viruses
- Improve concentration methods - no way to successfully separate viruses from other particles
- Use chelation beads to chelate away humics and other materials that inhibit PCR.
- Use "Molecular Beacons" as a way to quantify virus products without having to run gels.

Question-and-Answer Session

Panel: Jake Joyce, Steve Schaub, and Rachel Noble

Q (Sydney Harvey, Los Angeles County Department of Health Services): This question is for Dr. Noble. Your slides showed a good array of viruses that are not, by definition, enteric viruses other than they are shed in the feces. Are you multiplexing for all of these RNA viruses or are you looking for an individual virus? In other words, if it is negative for adenoviruses, do you go on to hepatitis A?

Rachel Noble:
I did not want to give the impression that I was testing for hepatitis A or adenovirus, although I have done that work in the lab. The results are solely from the use of primers that were designed to only detect human enteric viruses.

Q (Sydney Harvey): Are you looking for coxsackiesvirus, echovirus, poliovirus? Are you looking for all of them in every sample or are you honing in on something like poliovirus that is most commonly seen because of oral vaccines?

Rachel Noble:
I was looking for them in every sample as a family because the primers are just a single primer pair that is based on a human enteric virus sample. The primer pair that was used has been shown, in the past, to detect 25 serotypes of the human enteric virus family.

Q (Sydney Harvey): Have you tried to differentiate when you have a positive PCR?

Rachel Noble:
Only in specific cases, not overwhelmingly.

Q (Sydney Harvey): In California, we have not seen, in terms of culturing, a lot of enteroviruses. So it might be interesting to see specifically what kinds of enteroviruses you are finding in the water. How did you put 40 liters of seawater through a 0.2-micron filter? Do you centrifuge it first?

Rachel Noble:
We use a stainless steel pressure filtration unit, and it goes up to many pounds per square inch so the water is being forced through the filter. For some of these storm drain samples, it can take 8 to 10 hours just to filter.

Q (Dr. Jack Skinner, Stop Polluting Our Newport): In the medical profession, we use enteroviruses as coxsackiesvirus, echovirus, poliovirus. When we talk about enteric viruses, it represents a whole collection that might also include Norwalk and rotaviruses. Are you measuring enteric viruses that would include the ones that are believed to be a problem for swimmers, like rotavirus or Norwalk-type virus? Or are you measuring enteroviruses where you might be dealing with attenuated poliovirus?

Rachel Noble:

The primers that were designed for the work that I was doing were for the pan-enterovirus family. So, it is the enterovirus family that is the subset of the human enteric viruses that we are detecting, namely, coxsackiesvirus, echovirus, and poliovirus.

Q (Dr. Jack Skinner): So there is a big group out there that probably is responsible for the illnesses that we are concerned about with swimming. Which would probably be mostly Norwalk-type virus and rotavirus.

Rachel Noble:

Right.

Q (Dr. Jack Skinner): My second question has to do with F-specific phage. From what I understand, F-specific phage is not found in the human intestinal tract, except in maybe 2 percent of people. [This information was from a Japanese study of 100 people and does not represent a global distribution.] It is wastewater-related, but not fecal-related. Does this throw off your monitoring? If you are looking for wastewater, you could find F-specific phage. If you are looking at swimmer density or for boat discharges in a harbor where this is direct fecal input, you would not find F-specific phage because it does not multiply in the gastrointestinal tract.

Rachel Noble:

Right. I have done some work in conjunction with a professor at UCI and we are trying to relate the presence of the F-specific phage infectivity to our PCR research on enteroviruses. It's a really good question, and in Los Angeles some of the problems that we have seen are like what you're talking about. Septic system overflows and things like that might come from the natural population and not from the treatment plant. I think that in doing this work, the intent was to be looking for human fecal contamination via a poliovirus. In some cases, we are making the assumption that poliovirus will still be found in those samples, but I don't know how much of it will be found in different treatment scenarios. I am not sure how the enteric viruses, as a group, relate to one another in relation to what type of treatment process they've gone through as far as the numbers are concerned. There is no way for me, at this point, to differentiate between the ocean and the storm drain in the ocean. The material is probably coming from a variety of sources. It is a difficult question to answer because there are different types of scenarios where we see different levels of different types of viruses or different phages.

Q (Clay Clifton, San Diego County Department of Environmental Health): Since the implementation of AB411 on July 26, which is the new state regulation and guidance for monitoring and posting for California beaches, in San Diego, we have had about six exceedances of the enterococcus indicator that have subsequently required a posting of a beach. In those same sample results, the fecal coliform counts are lower than the enterococcus counts. How do you explain lower fecal coliform counts than enterococcus counts if the enterococcus are within the fecal coliform group? Also, is it possible for the fecal coliform indicator to give a false negative for enterococcus?

Jake Joyce:

Coliforms are a rod-shaped bacteria, bacilli, not cocci like enterococcus. They both are enterobacteria, but they are not the same thing. Some fecal coliforms can die off, where enterococcus can survive much longer in the natural environment. That may have something to do with the time of the sampling or where you sampled. Enterococci can persist longer in the environment than many of the fecal coliforms. Due to the natural attenuation process, a lot of them can't outlast the natural microbes in the environment. Sometimes fecal coliforms can be attenuated by natural processes, including other microbes and things that they give off and so forth, where enterococci live longer than the fecal coliform in certain situations. A lot of it again has to do with sampling. That is the reason why we are moving into the enterococcus and *E. coli* rather than fecal coliforms. Enterococcus persist much longer in marine water also.

Q (Clay Clifton): Is the fecal coliform test specific for bacillus and does not include the enterococcus as a class of bacteria?

Jake Joyce:

Enterococci used to be called the Lancefield Group D streptococcus years ago. Coliforms and enterococci belong to the Eubacteriales. Enterococci are shaped differently from coliform and are an entirely different microorganism.

Q (Roger Fujioka, University of Hawaii): The problem is to get an assay that is fast and detects health risks, which are the viruses that Dr. Noble has been testing for. How do you correlate volume testing of bacteria to viruses with larger numbers? What is real-time, if the RT-PCR takes 17 hours and you can get a coliform result in 18 hours with Colilert®. Is that sufficient for real-time? With the IC integrated cell culture PCR, where do you think that we should be heading for monitoring purposes for these pathogens? Dr. Noble, I hope that you would look for PCR with Clostridium because your correlation with enterococcus probably relates to their stability and since Clostridium is more stable you might find a correlation also.

Steve Schaub:

I don't think there are any fecally borne microbial indicator candidates that occur at levels in the water that would allow us to use them as tools for very rapid analysis. We will probably have to rely on chemicals or possibly other types of antigens that are specific to feces, and which would be present in fecally contaminated waters at higher concentrations which we can detect with rapid analytical methods. I think that the rapid dip-stick methodologies can be developed and linked in a tiered approach whereby a positive dip-stick would trigger a more sophisticated indicator or possibly pathogen measurements of water samples. Also, at the International Calicivirus Conference held last March, it became apparent that one of the things public health practitioners had theorized, that the rotaviruses and the caliciviruses were a major component of the gastrointestinal disease burden for recreational waters, was not likely to be an accurate assessment. To the contrary, at least internationally, it seems that calicivirus and rotaviruses predominate during the winter months both in the northern and southern hemispheres and not in the summer during the swimming season, so we may have to look for new culprits as the causative agents for acute gastrointestinal disease in swimmers. Our two prime candidates would appear not to be at high levels during the summer swimming months.

Rachel Noble:

I will address the detection that is related to the infectivity. My work has been done on RNA viruses. When we detect RNA in these samples, we are pretty certain that human enteric viruses were in the sample relatively recently, if not intact at the time we detected them, because RNA degrades rapidly. This can be very different for DNA viruses. The processes that affect DNA and RNA are very different. This may be a situation where a more logical process of monitoring is needed, where we have indicators or a developed dip-stick method and the results read to a flow chart on what to do next. Then you go after specific types of bacterial indicators and then viral indicators. If the bacterial indicators are down to about 5-10 per 100 mL and you are detecting human enteric viruses, especially in some areas of Santa Monica Bay where there's been some demonstrated relation between the viruses and health risk from an epidemiological study that was conducted there, then there is good evidence that we should have a more logical flow chart of sampling where we are going in different directions for different types of scenarios. Temperate versus tropical is going to give you different results just based upon the indicator that you used. I think that there are some possibilities out there for combining some probe and PCR detection of viruses specifically that haven't been completely eliminated from the possibilities. The combination of using fluorescent probe quantification with amplification using PCR over a short time span may get the samples down to a couple of hours rather than 24 hours.

Steve Schaub:

Regarding sample volume requirements, as a corollary, we are starting to look at larger sample volumes for bacteriophage indicators in groundwater. We are thinking of increasing from a 100 mL to a liter-size sample to increase our sensitivity to detect the potential for virus contamination. We need to address the question: why do we have proportionally low sample volumes to look for indicators which themselves may be significantly reduced in the groundwater environment when we are trying to estimate low levels of viruses but for which only one infectious unit may cause disease. We may have to increase our sample volumes for some of the new indicator candidates to achieve the sensitivity we need to detect potential presence of disease organisms for recreational waters.

Q (Frank Alvarez, Santa Barbara County Public Health): This question is a follow-up on the infectivity of the viruses and determining health risk. We should not only look at the type of virus, but consider the viability of the virus. Did you do any follow-up viral cultures to look at any correlation between the lack of correlation between the viruses that you were detecting and fecal coliform counts in some of the samples?

Rachel Noble:

I have pursued some work in relating the RT-PCR results to cell culture that was done out of house because we do not have the capabilities to do cell culture at USC. More recently, we have taken water samples to analyze for multiple groups such as adenovirus, enterovirus, coliphage, and coliphage infectivity to find the relation between those samples. We have not finished analyzing all of those samples, but in terms of relating all of the different groups of viruses, the processes that go into the degradation and loss of viability or infectivity are very complex, but they definitely need to be teased out. It had been shown before that different viruses, for example, respond much differently to different types of inactivation. Those types of experiments are going to be very important in the future. The relationship between the MS2 and poliovirus has shown that the poliovirus is extremely hardy where MS2 will fall apart easily. There are very big differences between different types of viruses and taxa of viruses.

Q (Ken Burger, East Bay Regional Park District): We are in the process of struggling with the new emphasis on beach monitoring. As you are aware, the marine regulations have gone into effect and there is a freshwater guidance document also in the process. This has increased our monitoring costs by approximately $200,000 a year to implement these new regulations. We have eight freshwater beaches and two marine water beaches that we monitor. Concerning the issue of rapid response, do you have a preferred method? Are MPN, Colilert®, and Millipore filter all acceptable?

Jake Joyce:

One of the big problems when you use membrane filtration techniques is turbidity. If you have a turbid sample, you may want to consider using the multiple-tube fermentation technique since you will probably clog your filter and not get a good colony count.

Q (Ken Burger): Our concern is that the MPN, the multiple- tube method, is a much longer test, so it puts you back in that scenario where you are testing on Saturday and getting results on Wednesday and trying to figure out what it means. It is too late after the monitoring to be an effective management tool.

Jake Joyce:

I have some pictures of Millipore filters that are just clogged from natural turbidity. So, you would want to use a multiple-tube fermentation technique. It is much easier to do a membrane filtration technique, but sometimes you can't do it.

Q (Charles Kovatch, US EPA Office of Science and Technology): As we saw from all three presentations today, there is a need to establish consistent sampling. How close to sewer outfalls did you sample and how did you select those sites? Did you utilize any plume modeling? What depth of the water did you sample? How did you derive that sampling methodology?

Rachel Noble:

In southern California, the storm drain systems are separate from the sewer systems although at some low-flow periods, some storm drains are directed into the sewer system. All of the samples that I have taken are not from sewer outfalls. They have been from freshwater outlets such as concrete lined storm drains, creeks, and rivers. They were sampled at locations where the bacteriological monitoring was actually done. Except from bridges, most of the samples were taken in 3-18 inches of surf zone water, in areas where the waves were actually meeting the creek. Not in the storm drains. This is because I wanted to reduce the amount of variability in trying to relate some of the bacterial numbers. I tried to take the samples at the same time on an incoming wave, as written in the standard methods. The salinity of the seawater samples was between 32 and 33.5 parts per thousand.

Q (Charles Kovatch): Has research been performed on the path of the contaminants once the plume meets the ocean?

Rachel Noble:

There has been a great deal of research regarding water quality, such as total suspended solids, for example, in Santa Monica Bay to try to map the plumes. It is something that we are very interested in doing, but we haven't gotten out to do the sampling. We want to try to relate all of the satellite and remote sensing, total suspended solids, and current measurements to the pathogen levels and the bacterial indicator levels all the way out into a plume. This is the work that will be going on this fall and spring in Santa Monica Bay. At this time, I have only done a very limited scenario of detection of the specific viruses by PCR upstream through downcoast because it takes a long time. Modeling fate and dispersal of the pathogens is one of our main problems and goals for the future.

Session Two: Risk Assessment, Exposure, and Health Effects

The Relationship of Microbial Measurement of Beach Water Quality to Human Health

Al Dufour
US Environmental Protection Agency, National Exposure Research Laboratory

The bacterial indicator concept has been used for more than 100 years and is today a key element in maintaining the quality of recreational waters. Early use of bacterial indicators was not risk-based. The presence of bacterial indicators signaled the presence of fecal material, and this alone was considered hazardous enough to disqualify the use of the contaminated water. In the late 1940s indicator bacteria were used quantitatively to measure the quality of recreational water, and these data were used to determine whether the water quality was related to health effects associated with swimming activity. Health effects were found to be related to contaminated recreational water. These findings were extended and refined by U.S. EPA studies in the 1970s on the relationship between water quality and swimming-associated health effects. These data were used by EPA to develop guidelines for maintaining the quality of recreational water. The findings of the EPA studies have been confirmed in studies around the world and lend credence to the approach used in the United States to protect the health of swimmers.

The establishment of a risk-based approach to protecting the health of swimmers has not, however, solved all of the issues related to maintaining high-quality recreational waters. The U.S. EPA's *Action Plan for Beaches and Recreational Water* has discussed a number of these issues, many of which are related to indicator bacteria. Three of these issues, which frequently raise questions from water resource managers, involve indicator bacteria. All currently recommended indicator bacteria demonstrate the presence of fecal material from warm-blooded animals without distinguishing whether the source is human or animal. Research findings regarding health effects associated with nonpoint sources of pollution, i.e., animal or bird contamination of water, are equivocal. Data from past research will be used to further define this issue. Another issue which frequently raises questions is whether the risk of swimming in waters that receive discharges from a combined sewer overflow (CSO) is the same as that encountered in waters affected by treated wastewater from a point source. Health data associated with exposure to CSO discharges that affect recreational waters is not available; however, it is possible to speculate on the risk due to this type of exposure using microbial data from the analysis of wastewaters that pass through sewage treatment plants and data from studies on storm water runoff. The last issue to be discussed in this presentation will address the question of new indicators for measuring recreational water quality and whether a new indicator can be substituted for a standard indicator without establishing its relationship to health effects. This is especially important because of the rapid proliferation of new technologies for measuring the quality of surface waters. The foregoing issues will be discussed with regard to currently used indicator bacteria, fecal coliforms, *E. coli*, and enterococci.

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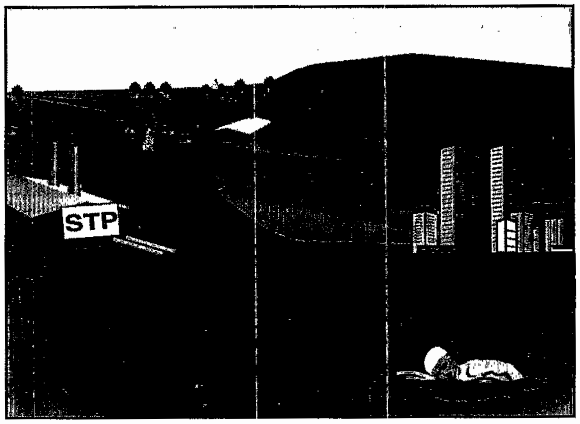
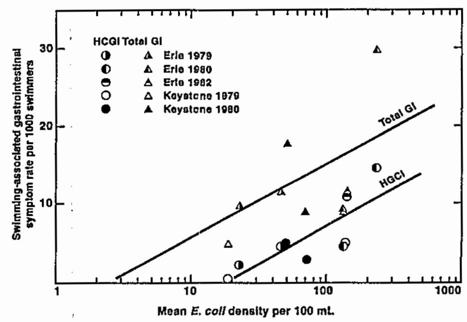
Epidemiological Studies Connecting Microbial Load in Beach Water to Human Illness



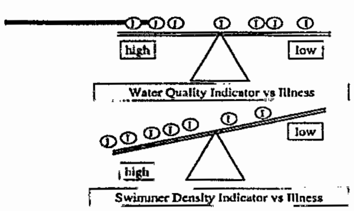
Indicator Concept

- Intestinal disease linked to water
- Pathogen cannot be cultured
- How to measure risk?
- Measure easily cultured microorganism constantly associated with feces
- Bacterial indicator = feces
- Feces = pathogen
- Pathogen = disease



Estimate regression lines for highly credible and total gastrointestinal symptom rates on *E. coli* densities.

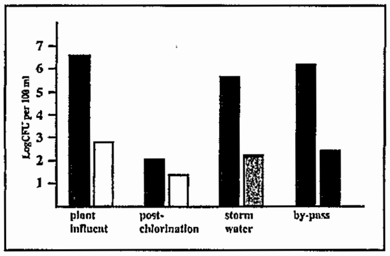
Nonpoint Source Pollution and Swimming-Associated Illness

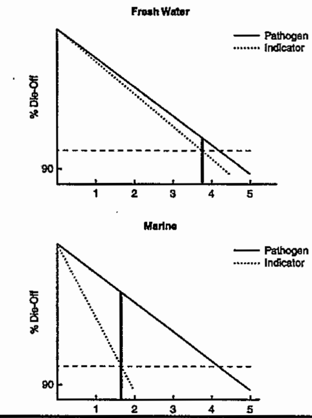


Association between cases of gastrointestinal illness and various monitored parameters

Monitored Parameters	Relative Risk	P value
Rainfall	2.1	0.089
Enterococci	1.9	0.059
E. coli	1.4	0.412
Fecal Coliform	1.7	0.159
Bathers	4.8	0.011
Straphylococci	2.6	0.026

Indicator Bacteria and Enteroviruses in Raw Sewage and Storm Water



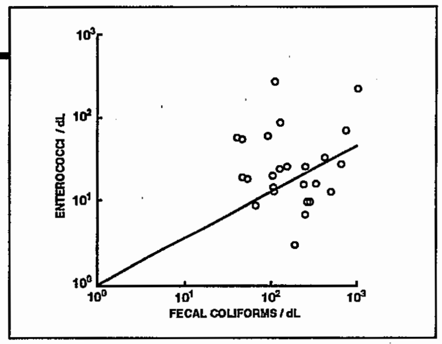


Correlation Coefficients-Enterococci Regressed on Fecal Coliforms

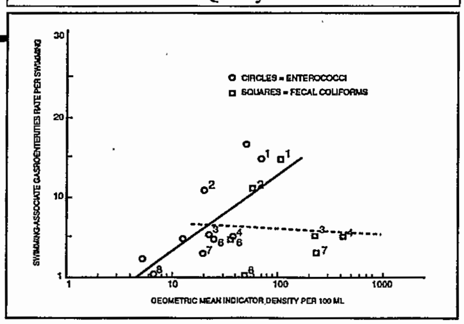
Beach	Year	Correlation Coefficient
Erie	1980	0.45
Erie	1982	-0.24
Keystone	1980	0.45*
Keystone	1979	0.83*
Erie	1979	
Erie	1980	0.98*
Keystone	1980	0.79*
Keystone	1979	0.71*

*Correlation Coefficient Significantly Different from Zero

Regression of Enterococci on Fecal Coliforms



Relationship Between Swimming-associated Illness and Water Quality Indicators

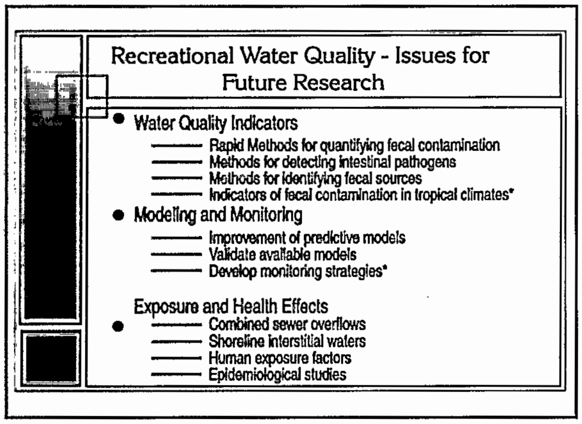


Ratio of Thermotolerant *Klebsiella* to Fecal Coliforms in Water Samples from Freshwater Bathing Beaches

Thermotolerant *Klebsiella* as a Percentage of Fecal Coliforms

Sample No.	*Klebsiella*[1] / Fecal Coliforms	Percent *Klebsiella*
1	16/92	17.4
2	170/760	22.4
3	18/80	23.5
4	66/279	23.6
5	15/61	24.6
6	37/143	25.9
7	135/448	30.1
8	31/101	30.7
9	30/93	32.3
10	24/72	33.3
11	60/165	36.4
12	8/220	36.4
13	27/73	37
14	34/89	38.2
15	50/126	39.7
16	24/44	54.5
17	122/205	59.5
18	75/121	62
19	102/161	63.3
20	62/98	63.3
21	100/136	73.5

[1]Density per ml x 100


Recreational Water Quality - Issues for Future Research
Water Quality Indicators
Rapid Methods for quantifying fecal contamination
Methods for detecting intestinal pathogens
Methods for identifying fecal sources
Indicators of fecal contamination in tropical climates*
Modeling and Monitoring
Improvement of predictive models
Validate available models
Develop monitoring strategies*
Exposure and Health Effects
Combined sewer overflows
Shoreline interstitial waters
Human exposure factors
Epidemiological studies

Qualitative Review of Epidemiology Studies

David Gray
Massachusetts Department of Environmental Protection, Northeast Regional Office

The Massachusetts Department of Environmental Protection (DEP) has conducted a review of epidemiological studies relative to pathogen indicators and illness rates in recreational water users. The work was conducted as a state match to a federally funded Clean Water Act Section 104(b)(3) grant. The project involved reviewing published literature and in some cases nonpublished epidemiological studies. Both the methodologies and the conclusions of the studies were reviewed in detail. The review was primarily conducted by Tom Mahin, the Co-chair of DEP's Pathogen Work Group. David Gray of DEP has assisted with issues raised relative to microbiological sampling QA/QC issues, as well as DEP's storm water-related issues, and has acted as an advisor during the review. It should be noted that the opinions expressed in this summary are not intended to represent DEP's formal policy relative to this complicated and important issue. Rather, they are presented as part of an ongoing dialogue between USEPA, the states and other stakeholders.

In 1986 the USEPA recommended that states use enterococci as the bacterial indicator for marine waters and either enterococci or *E. coli* as the indicator for freshwaters (Dufour, 1986). We have summarized some of the most important epidemiological studies since that 1986 recommendation:

During 1989-1992 during four consecutive summers, epidemiological studies (the "UK beach studies") were carried out at marine beaches in England (Kay, 1994; Fleisher, 1996). The UK beach studies differed from previous epidemiological studies in two important ways. First, volunteers were randomly assigned as either bathers or non-bathers. Second, rather than relying on self-describing of symptoms, clinical examinations were included as part of the study. The studies involved a total of 1216 participants. The studies found a dose-response relationship between fecal streptococci (FS) and gastrointestinal (GI) illness. (It should be noted that the definition of fecal streptococci as used in these studies is very similar to or the same as enterococci as used in the U.S.) An increase in GI illness rates was observed when FS levels exceeded 32 colony forming units (cfu)/100 mL.

The studies also reported what was described as a "clear dose-response relationship" between respiratory illness and fecal streptococci levels. The threshold level for increased illness was 60 cfu/100 mL. While these studies only dealt with marine waters and not fresh waters, the results appear consistent with the work done for USEPA by Cabelli (Cabelli, 1983) that indicated that enterococci works well as an indicator of rates of GI illness in marine waters whereas fecal coliform does not. It should be noted, however, that these studies in England did find that only fecal coliform demonstrated a significant statistical correlation with ear infections.

A major epidemiological study was conducted in Hong Kong in 1992 involving 25,000 beach-goers at coastal beaches (Kueh, 1995). Unfortunately the study did not include analyses of fecal streptococci/enterococci densities. The study did find that "no direct relationship between GI symptoms and *E. coli* or fecal coliforms could be identified in this study." The findings of the study appear consistent with USEPA's position that fecal coliform and *E. coli* are not effective at predicting GI illness in users of marine waters. The 1992 study did contradict a 1987 study (Cheung, 1989) of coastal beach-goers in Hong Kong that had found that *E. coli* was the best indicator for predicting illness.

An epidemiological study was conducted in 1995 of swimmers in the marine waters of Santa Monica Bay (Haile, 1996). The study included 11,686 subjects. Illness rates were compared for those swimming near storm water outfalls versus those swimming farther away. Illness rates were also compared to various bacterial indicators. Fecal coliform levels > 400/100 mL correlated only to skin rash and *E . coli* correlated only with earache and nasal congestion. Enterococci levels >106/100 mL were statistically correlated with "highly credible GI illness" and also with "diarrhea with blood."

Conclusions and Unresolved Issues

How much of a risk does wet weather storm water/urban runoff pose to recreational beach-goers? The Santa Monica study doesn't appear to have answered this question because the samples appear to have been collected daily, which would presumably include mostly dry weather flow contributions. The dry weather flow presumably could have included significant amounts of illicit sanitary connections that could have been responsible for a significant percentage of the illness rates detected. None of the epidemiological studies reviewed appear to have differentiated between dry and wet weather conditions. Many of the high bacterial indicators detected at Massachusetts beaches appear to be the result of urban runoff conveyed by municipal storm water drainage systems. Given the high enterococci counts that can be commonly detected in storm water and the general presumption that animal waste is a lesser cause of illness than human sewage, this issue is of critical importance.

Should a single indicator or multiple indicators be used for marine waters? USEPA recommends the use of either *E. coli* or enterococci for freshwaters but only enterococci for marine waters. The UK beach studies found that only increased levels of fecal coliform organisms were predictive of ear ailments among bathers in the coastal waters studied. In addition, the Santa Monica epidemiological study found that *E. coli* was the best predictor of earache after swimming in the marine waters involved in the study.

It is unclear what the source is of contamination in many of the studies reviewed. It appears that some of the major epidemiological studies involve contamination resulting mostly, or in part, to chlorinated effluents. This would result in the potential to significantly decrease the indicator-pathogen ratio in receiving waters. In addition, this could alter the ratio of various indicators to each other depending on their relative susceptibility to chlorination. Since one could generally presume that storm water-impacted waters are unchlorinated, they may exhibit higher bacterial indicator-pathogen ratios than those found in many of the studies (which are equivalent to lower pathogen-indicator ratios). Such a lower pathogen-indicator ratio (if confirmed) when added to the issue of risk from animal source contamination versus human source would have the potential to overestimate the risk relative to many of the previous epidemiological studies.

In conclusion, the authors believe that additional research is required relative to unresolved issues such as the issues raised above relative to wet weather (municipal storm water) events and the relative risk of indicators originating from animal sources versus human sources.

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Haile, W., et al. *1996. An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay*. Final Report. California.

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Qualitative Review of Epidemiological Studies

Tom Mahin & David Gray
Massachusetts Department of Environmental Protection

Background

- Epidemiological studies reviewed relative to pathogen indicators and illness rates in recreational water users
- Main focus was to evaluate studies completed since USEPA's 1986 recommendations relative to the use of enterococci (in marine waters) and *E. coli* or enterococci (in freshwaters) as bacterial indicators for ambient water quality criteria

Marine Water:	enterococci < 35/100ml
Fresh Water:	enterococci < 33/100ml or *E. coli* <126/100ml

Select Epidemiological Studies

Marine Water
- United Kingdom (Fleisher, 1996; Kay, 1994)
- Santa Monica Bay (Haile, 1996)
- Hong Kong (Kueh, 1995)
- Hong Kong (Cheung, 1989)

Freshwater
- Yale University/New Haven, CT (Calderon, 1991)

Epidemiological Study Designs

Retrospective
- attempt to relate existing/past cases of illness to swimming
- data is collected "after the fact"

Prospective
- participants are recruited from the beaches, but follow their own bathing/non-bathing routine
- participants are screened for confounding factors, and interviewed regarding symptoms of illness

Randomized Controlled
- participants are recruited and randomly assigned to swimming or non-swimming groups
- Universally accepted as the strongest of all epi-study designs

Definitions of Illness

Enteric Illness
- Gastroenteritis (GI) - combinations of vomiting, diarrhea, nausea

Nonenteric Illness
- Respiratory illness - fever, headache/body ache, fatigue, sore throat, runny nose, congestion, cough
- Eye ailments - sore, red eyes, with or without discharge
- Ear ailments - pain with or without discharge
- Skin ailments - rash, ulcers/sores, irritation with itching

Past Review of Epi-Studies

Prüss (1998) published a review of 22 studies completed between 1953 and1996 and concluded:

- Studies strongly suggest a causal dose-related relationship between GI symptoms and bacterial indicator counts in recreational waters.
- Few studies showed relationship with other symptoms
- Relative risk for swimming in polluted vs. clean waters ranged from 1 to 3

Past Review of Epi-Studies (cont)

- Indicators showing best correlation with illness
  - marine waters: enterococci/fecal streptococci
  - fresh waters: enterococci/fecal streptococci and *E. coli*
- No relationships identified between severity of symptoms and variation in indicator densities
- Symptom rates were usually higher in the lower age groups
- The higher indicator thresholds for increased illness rates observed in some countries may be due to endemicity or lower pathogen-to-indicator ratios

UK Studies

Design

- Joint US and English research effort, randomized controlled studies
- 1216 participants, age 18+, at 4 separate marine beaches in England
- Conducted during 4 summers between 1989-1992
- Intensive water sampling (every 30 minutes) at 3 depths every 60 feet
- Sampled for fecal coliform, total coliform, fecal streptococci (similar to enterococci), staphylcocci, pseudomonas aeruginosa. *E. coli* not enumerated

UK Studies (cont)

Findings

- Only fecal streptococci demonstrated a significant trend relating concentration to gastroenteritis rates
- "Only fecal streptococci exposure ... showed any evidence of a statistically significant trend" for acute respiratory illness
- Only fecal coliform showed statistically significant trend in the incidence of ear ailments

Santa Monica Bay Study

Design

- In the summer of 1995, first large-scale epidemiological study in the U.S. conducted to investigate health effects associated with swimming in ocean waters impacted by stormwater outfalls
- Included over 11,000 swimmers and non-swimmers
- Water analyzed for fecal & total coliforms, enterococci, and *E. coli*

Santa Monica Bay Study (cont)

Findings

- Study found an increased risk of illness associated with swimming near flowing storm drain outfalls (37 additional illnesses per 1,000 swimmers)
- Fecal coliform was only statistically associated with skin rashes
- *E. coli* was only statistically associated with earaches & nasal congestion

Santa Monica Bay Study (cont)

Findings (cont.)

- Enterococci statistically associated with diarrhea-with-blood and "highly credible gastrointestinal illness"
- Conclusion - Enterococci was the best indicator for predicting GI illness in swimmers, which was the the most common adverse health impact found
- Contamination probably included significant contribution from illicit sewage connections

Hong Kong - 1992 Study

Design

- 18,000 participants, between the ages of 10 and 49, at 2 popular coastal beaches during the Summer 1992
- Water samples were composited from three samples, at three sites, at each beach
- Sampling included fecal coliforms, *E. coli, clostridium perfringens, Aeromonas spp., Vibrio cholerae*
- Did not include analyses for enterococci/fecal streptococci

Hong Kong - 1992 Study (cont)

Findings

- No direct relationship found between GI symptoms and fecal coliform or *E. coli.*
- However, significant relationship found between GI symptoms and *clostridium perfringens, Aeromonas,* and turbidity
- No significant relationship between indicators and respiratory, eye, or skin illness
- Total additional (swimming-related) illness rates - 41 per 1,000

Hong Kong - 1987 Study

Design

- 1987 study of coastal beach-goers that included over 18,000 useable responses at 9 beaches
- Samples taken every 2 hours, at three sampling points, at each beach on the weekends
- Samples analyzed for fecal coliform, *E. coli,* fecal streptococci, enterococci, stapylococci and other indicators

Hong Kong - 1987 Study (cont)

Findings

- Total additional (swimming-related) illness rates - 30 per 1,000
- *E. coli* correlated best with GI illness and skin symptoms (threshold value of 180/100 ml)
- Relatively low correlation found between enterococci/fecal streptococci and GI illness
- Staphylococci correlated best ear, sore throats, and total illness (threshold value of 1,000/100 ml)

Yale/New Haven, CT Study

Design

- 104 families resulting in 1,310 exposure person-days for swimmers and 8,356 exposure person-days for non-swimmers during summer months
- 3-acre river-dammed pond with no point sources of pollution
- Daily samples collected 3 times per day at two locations
- Precipitation measured daily
- Participants mailed-in self-completed questionnaires

Yale/New Haven, CT Study

Findings

- Swimmer illness was not associated with elevated common fecal indicator densities or rainfall/stormwater runoff
- Swimmer illness was associated with high swimmer densities and high staphylococci densities (illness probably transmitted swimmer-to-swimmer via water column)
- Currently recommended indicators are ineffective at predicting health effects associated by non-point source (i.e., animal source) fecal pollution

Unresolved Issues

- Wet Weather Stormwater/Runoff
  - How much of a risk does wet weather stormwater/urban runoff pose to recreational water users?
  - How much of a relative risk are equivalent levels of indicators when the source is animals versus humans?
  - Calderon (1991) showed no association with increased illness
- Marine vs. Freshwater Waters
  - Many of the more recent studies have been on marine waters, there have been less recent studies relative to freshwater beaches

Unresolved Issues (cont)

- Use of Single or Multiple Indicators
  - Is a single indicator adequate or should more than one bacterial indicator be used for respiratory or eye, ear and skin illness?
  - UK studies indicated that fecal coliform were the best indicator for predicting ear ailments/earaches
  - Santa Monica Bay study indicated that *E. coli* was the best indicator for predicting ear ailments/earaches
  - Original EPA studies showed no increase in ear infections and only a slight (non-significant) increase in respiratory illness when the average fecal coliform concentration = 200/100ml (PC/Dufour)
  - Literature has shown slight relationships between fecal coliformand non-GI symptoms, but only at the outer-limits of significance (PC/Dufour)

Unresolved Issues (cont)

- Chlorinated vs. Unchlorinated Waters
  - Several of the studies were based on chlorinated waters
  - Indicators are eliminated at a much higher rate than viruses during treatment and disinfection
  - Therefore, chlorinated waters will result in lower indicator-to-pathogen ratios
  - Indicators more valid when pollution source is not disinfected, resulting in a higher indicator-to-pathogen ratio

Unresolved Issues (cont)

- Transferability of Study Results

Results valid for different countries/continents?
- Different climates - temperate vs. tropical
- Different endemicity rates
- Different indicator-to-pathogen ratios

Results valid for different contributing populations?
- Indicator-to-pathogen ratios may vary greatly as population contributing to the pollution source decreases

Pathogen Risk Assessment Methods

Steve Schaub
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The current recreational water quality criteria are considered risk-based in that they were established after studies demonstrated a relationship of the magnitude of fecal indicator organism levels (enterococci and *E. coli*) and relative incidence of disease in persons swimming at contaminated beaches. Improvements in indicators and additional health studies may allow further refinements or new criteria to protect the health of persons swimming in our nation's waters. To maximize our ability to provide risk-based criteria or to determine the safety of beach waters, improved risk assessment approaches should be applied. These should consider the unique features of microbial pathogens in water that lead to human exposure and also the unique features associated with human infection and disease.

A framework has been developed for conducting pathogen risk assessments for water media and various types of exposure settings. The framework follows a classic risk assessment approach in that there is a Problem Formulation stage, an Analysis stage, and finally a Risk Characterization stage which provide the risk manager or user with answers to problems identified during problem formation. One of the key features of the pathogen risk assessment is that iterative loops are considered important throughout the process, both to obtain the appropriate problem formulation and to properly assess the factors used for the analysis.

The analysis phase is broken down into two major divisions: Characterization of Exposure and Characterization of Human Health Effects. There are a number of tools and methods to use in data collection for the two major divisions of the analysis phase. For Characterization of Exposure the process is broken down into four blocks of data collection and analysis: Pathogen Characterization; Exposure Analysis; Pathogen Occurrence; and finally Exposure Profile (a synthesis of findings and associated uncertainties observed with the first three groups). Under the Characterization of Human Health Effects division there are also four blocks for analysis: Host Characterization; Dose Response Analysis; Health Effects; and again, a synthesis of findings and uncertainty in the Host Pathogen Profile.

The final step, Risk Characterization, is an exercise of evaluating all of the exposure and host-pathogen profile data inputs along with the uncertainty, estimates, and modeling that were used during the analysis phase. The estimates of risk take into account the quality and variability of the data, uncertainty of the information, and lack of data and can apply a sensitivity analysis to provide the risk manager with a sense of what the risk assessment will allow him to do in his management decisions.

Risk assessment is a very iterative process and improved analysis tools and improved data will significantly improve subsequent Risk Characterization outputs, especially for recreational waters where there are sparse data on pathogen occurrence, exposure assessment, and health effects.

Pathogen Risk Assessment Methodology

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Risk Assessment Approach and Process for Recreational Waters

- Typically, environmental risk assessments are conducted for a single pathogen and type of exposure profile.
- For recreational waters risk assessments and criteria have utilized surrogates of fecal contamination.
  - Have been very few formal risk assessments for U.S. recreational waters.

Approach and Process (cont)

- The current risk-based recreational water health criteria:
  - Apply bacterial indicators to detect and assess risks considering the magnitude of fecal contamination.
  - Estimate fecal contamination relationship to acute gastrointestinal (AGI) disease from oral exposure by head immersion.
  - Protect against AGI disease, a general syndrome expressed by a number of viral and bacterial pathogens of fecal origin.

Approach and Process (cont)

- Future recreational water risk assessments may use fecal or other indicators for other exposures (skin, eye, ear, and URT).
  - A limiting factor is the lack of data on pathogen exposure response.
- Typical recreational water applications:
  - Develop new "risk-based" standards/criteria.
  - Determine risks from rainfall or pollution events at specific beaches.

Pathogen Risk Assessment for Waters

- ILSI coop with EPA has established a pathogen RA framework.
  - Risk analysis, vol. 16.6, 1996. pp 841-848.
  - Fully considers unique aspects of microbial pathogen exposures and human health effects.
  - Resembles EPA's ecological risk assessment process.

Pathogen Risk Assessment for Water (cont)

- New approach needed because NAS chemical paradigm does not adequately consider:
  - Pathogen amplification for die-off factors.
  - Environmental and treatment impacts on nature, fate, and transport of microbials.
  - Human infection vs. disease, secondary spread, and susceptible populations.

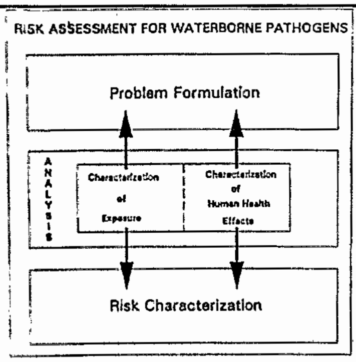


Figure 1. Generalized framework for assessing the risks of human disease following exposure to waterborne pathogens.

Characterization of Exposure

- Pathogen characterization: evaluate characteristics of pathogen that affect its ability for transmission to, and cause disease in host. For recreational use, rely on surrogates for assessing the range of viral and bacterial pathogens causing AGI disease:
  - Virulence and pathogenicity.
  - Survival and amplification of pathogens (in the environment).
  - Ecology of pathogens in the water system that impacts on occurrence at beach.

Pathogen Characterization (cont)

- Pathogen source responses to water treatment or intervention.
- Pathology on infection and strain differences on relationship to exposed population.
- Host specificity (animal vs. human strains).
- Route(s) of infection (oral for AGIs); also secondary spread.

Characterization of Exposure

- Pathogen (hazard) occurrence: frequency of appearance of a pathogen (or relation to the surrogates):
  - Spatial distribution, e.g., clumping, adsorption to particles, settling.
  - Concentration and distribution (depth, hydrology, gradients).
  - Frequency of distribution: pollution spills, rainfall runoff, diurnal events, seasons.

Pathogen (Hazard) Occurrence: (cont)

- Niche or habitat (e.g., accumulation in swash zone or growth in sand).
- Environmental amplification, die-off, persistence, e.g., temperature, predation, UV light, nutrients, suspension of sediments.

Pathogen (Hazard) Occurrence: (cont)

- Exposure analysis: Characterize the source and temporal nature of human recreational exposure to pathogens:
  - Type of recreation.
  - Measured unit of exposure (assume 100ml for swimming event).
  - Temporal nature of exposure (single or multiple).
  - Route of exposure and related transmission potential (oral for AGIs).

Exposure Analysis: (cont)

- Population demographics (age, susceptible, sensitive population).
- Size of exposed population.
- Behavior of exposed population.
- Location of bathers in the water (swash zone or deep water).

Exposure profile: qualitative or quantitative evaluation of the magnitude, frequency, and pattern of exposure to fecal contamination (Or pathogen).

- Integrate pathogen characteristics, hazard occurrence and exposure analysis.
- Provide statements regarding:
  - Analysis of likely pathogen occurrence and exposure of the population.
    - For recreational water assess the relationship of the surrogates to the pathogens/illnesses of concern.

Exposure Profile: (cont)

- Statements (cont)
  - Assumptions used in assessment: define when/where used and the range of impacts on the outcome of the assessment.
  - Uncertainties and data gaps: how dealt with and the impacts of poor quality data or lack of data on the analysis.

Characterization of Human Health Effects

- Evaluate the ability of pathogen (or indicator relationship) to cause adverse health effects under a set of conditions.
- Dependent on tools and methods available such as:
  - Disease outcomes and potential for sequella.
  - Epidemiology studies: cohort/intervention.
  - Clinical studies human feeding.
  - Animal model systems.

Host characterization: evaluate the characteristics of potentially exposed population that influence susceptibility to a pathogen.

- Collect and analyze data pertaining to the pathogen characteristics used in the exposure compartment.
- Examine data on host characteristics that influence susceptibility.
- Analysis of susceptible populations and characteristics that influence effects of pathogens (or groups of pathogens).

Characteristics That Influence Effects (cont)

- Age and Gender.
- Immunity.
- Pregnancy.
- Diet.
- Exposure Behavior in the Water.
- Sensitive Subpopulations.

Health effects: clinical manifestations of disease associated with a specific pathogen.

- Health effects: characterize clinical illnesses associated with pathogen single or multiple organs (e.g., heart, URT, liver, ear, skin diseases).
  - Characterize the potential extent and magnitude of illnesses from a pathogen, including secondary spread:
    - Seroconversion or subclinical severity and duration of frank disease.
      - Sequella.
      - Mortality.

Dose response analysis: characterize the relation between pathogen dose, infectivity, effects in exposed population.

- Establish relationship between dose, infectivity, and response.
  - Epidemiological studies.
    - Outbreaks
    - Cohorts/case control studies
  - Feeding studies
  - Animal studies (animal models for dose response estimation). Are they valid?

Host-pathogen Profile: Qualitative or Quantitative Evaluation of Nature and Potential Magnitude of Human Health Effects from a Specific Exposure. Developed from Integration of:

- Host-pathogen interactions.
- Health effects.
- Dose-response.
  - As was done for exposure characterization, characterize and make statements concerning: health effects data analysis; assumptions used; and uncertainties around data and data gaps.

Pathogen Risk Assessment (RA) for Water

Risk characterization:

- Estimation of the likelihood of adverse human health effects occurring as a result of a defined exposure to microbial contamination or medium (beach).
- Exposure profile and host-pathogen profile are integrated.
  - Determine the likelihood of adverse human health effects occurring from the defined recreational exposure scenario.

Risk Characterization (cont)

- Perform risk estimation to describe types and magnitude of effects anticipated (include all assumptions and uncertainty and an assessment of their impact on the ra).
- Prepare risk description to identify the confidence of the risk estimates and include consideration of the sufficiency and quality of the data and evidence of causality.
- Describe the adequacy of the assessment to adequately resolve the questions from the problem formulation questions, goals, and endpoints (e.g., Sensitivity analysis).

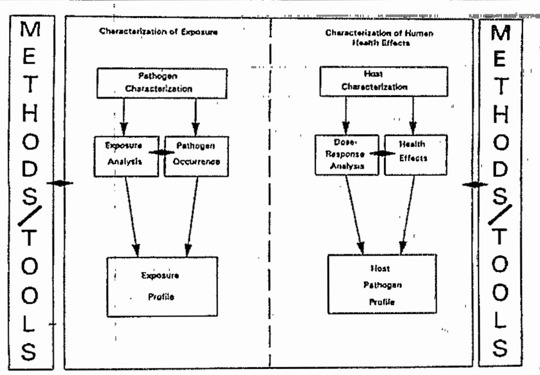


Figure 2. Analysis phase of risk assessment for waterborne pathogens.

Question-and-Answer Session

Panel: Al Dufour, David Gray, and Steve Schaub

Q (Fred Lee, G. Fred Lee Associates): A number of California cities face the removal of fecal coliforms from storm water runoff where there is limited sanitary sewage in the runoff. We know that highways have very high concentrations of fecal coliforms where we suspect that there is no sanitary sewage, except in leaking RVs. What is EPA's position on the need to remove fecal coliforms from storm water runoff where we have limited sanitary sewage and no CSOs?

Steve Schaub:

I don't think that we will be able to treat all environmental contamination monitoring problems using indicators in a one-size-fits-all approach. However, if you do have a storm water runoff situation and it does have high concentrations of fecal coliforms and there is a downstream use which will be impacted, then obviously it needs to be controlled and regulated. If the runoff is going to some area where there is no considered use downstream, then it could be handled differently. I am not the authority on local discharge requirements, but my perspective is that it will be handled based on the downstream requirement of whether or not it is going to be used for a human exposure scenario.

Q (Fred Lee): Would that be focused because of it?

Steve Schaub:

That is one of the problems. If we have a downstream use and until somebody can show that roadside waste runoff does not have a pathogen component, then we can't ignore it.

Comment (Patty Vainik, City of San Diego, Metropolitan Wastewater Department): It's my understanding of the Santa Monica Bay Epidemiological Study that total coliform and fecal coliform did have a relationship to health risk, not individually, but as a ratio. That has formed the implementation of our recent legislation, AB411, and two of the authors of the epi-study report are present, Mark Gold and Charlie McGee, who can probably speak to that.

David Gray:

That is correct. I was recently informed that the study was just published. As far as I read in the actual report and the summary, I didn't see that information. I do apologize for not including these findings in my presentation.

Comment (Mark Gold, Heal the Bay): I am one of the authors of that report and that was one of the findings of the study. Everyone on that study thought that the total-to-fecal ratio was going to show nothing, but we were shocked to see that it had the strongest correlation with the incidence of adverse health effects, including upper respiratory infections and stomach flu.

Q (Mark Gold): In the last presentation, there was some discussion on the fate and transport of runoff plumes and some of the impacts they have on exposure. Has EPA done anything in this arena to look at plume dispersion studies to see what the bacterial densities are with various differences from flowing drains and how this relates to current as well as how it relates to what the flow is coming out of the drain or stream?

Al Dufour:

EPA has not done that kind of study. As far as I know, that kind of study has not been done for years. There were a few studies done in the late 1960s off the California coast that looked at dispersion and transport. Somehow it came into disfavor due to the expense of such a study and other reasons. There is one study that has been conducted in the UK by the same team that did the health study. I don't know at what stage they are in of their research, but I suspect that it will be published one of these days.

Q (Ken Theisen, Santa Ana Regional Water Control Board): Does EPA know of any risk assessment models that have used MS2 phage as the indicator of pathogenic pollution? Also, what are your thoughts on the pros and cons of using MS2 phage in a risk assessment?

Steve Schaub:

Arie Havelaar of the Netherlands may have developed some information on that. MS2 phage falls within the group of our candidate bacteriophages that may be promoted as indicators if we can demonstrate that there is some correlation with a disease endpoint. I don't think that he has ever done an assessment specifically looking at a particular disease endpoint through a risk assessment e.g., comparing MS2 phage against acute gastrointestinal disease incidence. If phage can be demonstrated to be good indicators or any particular disease endpoints associated with fecal contamination then I would be in favor of using them.

Al Dufour:

None of the F-specific phage, to the best of my knowledge, have been used in studies relating water quality as measured with phage to health effects in swimmers. I think that is one of the reasons your question cannot be answered. The data are not there to do a good risk assessment.

Session Three: Monitoring and Modeling

New Jersey's Recreational Monitoring Program

David Rosenblatt
New Jersey Department of Environmental Protection, Division of Watershed Management, Atlantic Coastal Bureau

Local and state environmental health agencies that participate in the New Jersey Cooperative Coastal Monitoring Program perform sanitary surveys of beach areas and monitor concentrations of bacteria in nearshore coastal and estuarine waters to assess the acceptability of these waters for recreational bathing. These activities and the resulting data are used to respond to immediate public health concerns associated with recreational water quality and to eliminate the sources of fecal contamination that impact coastal waters. As part of this program, New Jersey Department of Environmental Protection (NJDEP) routinely inspects the 17 wastewater treatment facilities that discharge to the ocean. NJDEP also performs daily aerial surveillance of New Jersey nearshore coastal waters and the Hudson-Raritan estuaries to observe changing coastal water quality conditions and potential pollution sources.

The municipal utilities authorities, which manage the sewage treatment facilities and their ocean discharges, are an integral part of the overall monitoring program in New Jersey, and they are key to the improvement in and the current good quality of the state's coastal waters. Because of their unique observational positioning, lifeguards provide NJDEP with firsthand information regarding water and beach conditions. Citizen participation, particularly through reports of pollution sightings to NJDEP, is encouraged.

To implement the more comprehensive approach to the improvement of New Jersey's coastal water quality that the reduction of nonpoint sources of bacteria requires, NJDEP is working with private and public sectors to promote watershed management. The water quality data and beach closing numbers, therefore, will be used as indicators of the success of the strategies implemented to resolve water quality problems of various origins. To support this effort, the Cooperative Coastal Monitoring Program manager and staff were transferred from the Division of Compliance and Enforcement into the new Division of Watershed Management's Atlantic Coastal Bureau.

Monitoring Program Procedures

The State Sanitary Code *N.J.A.C.* 8:26 and the DEP *Field Sampling Procedures Manual* prescribe the sampling techniques and beach opening and closing procedures the agencies use for the Cooperative Coastal Monitoring Program. The agencies perform routine sampling from mid-May through mid-September on Mondays. Samples are analyzed for fecal coliform concentrations using DEP-certified laboratories, including those of the utilities authorities; MPN or membrane filter methods provide results within 24 hours of sampling. In 1998, as in a number of previous years, samples were collected and analyzed for enterococci from a subset of ocean and bay stations in all of the coastal counties as the state prepares for further federal direction in beach management.

The recreational bathing standard for all waters in New Jersey is 200 fecal coliforms per 100 mL of sample, and closings are based on two consecutive single samples. If the results from the first sampling of the week are within the standard, sampling is complete until the following week. If a sample from a station exceeds the standard, the water at that station is immediately resampled, and adjacent beaches are also sampled to determine the extent of the pollution. A sanitary survey of the area is also conducted. A second consecutive fecal coliform concentration exceeding the standard or the identification of a source requires closing of the beach. Health officials retain the discretion to close beaches for any public health reason, with or without water quality data.

In 1998, the program included water quality monitoring stations at 179 ocean beaches and 138 monitoring stations in bay areas. Most ocean stations are sampled to evaluate the water quality at several lifeguarded beaches in an "area" rather than just one lifeguarded beach. These areas consist of contiguous, similar beaches with no permanent pollution sources. Individual beaches with permanent sources are assigned monitoring stations. A monitoring station is assigned to each recreational bay beach because of their locations on noncontiguous shorelines.

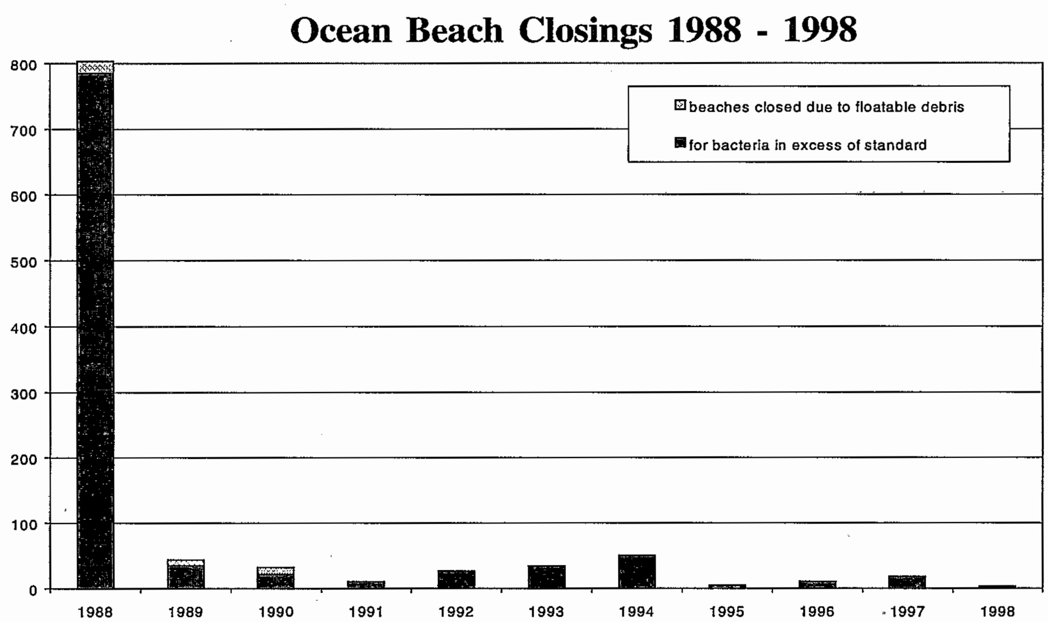
Results

Ocean beach closings due to floatables have been controlled for the past eight years, while closings in the ocean and bays due to bacteria have fluctuated with lower numbers in recent years (Table 1, Graph 1, and Graph 2). Ocean beach closings due to floatables have been controlled for the past eight years, while closings in the ocean and bays due to bacteria have fluctuated with lower numbers in recent years (Table 1, Graph 1, and Graph 2). Fecal coliform concentrations as geometric means have remained relatively consistent (Graph 3).

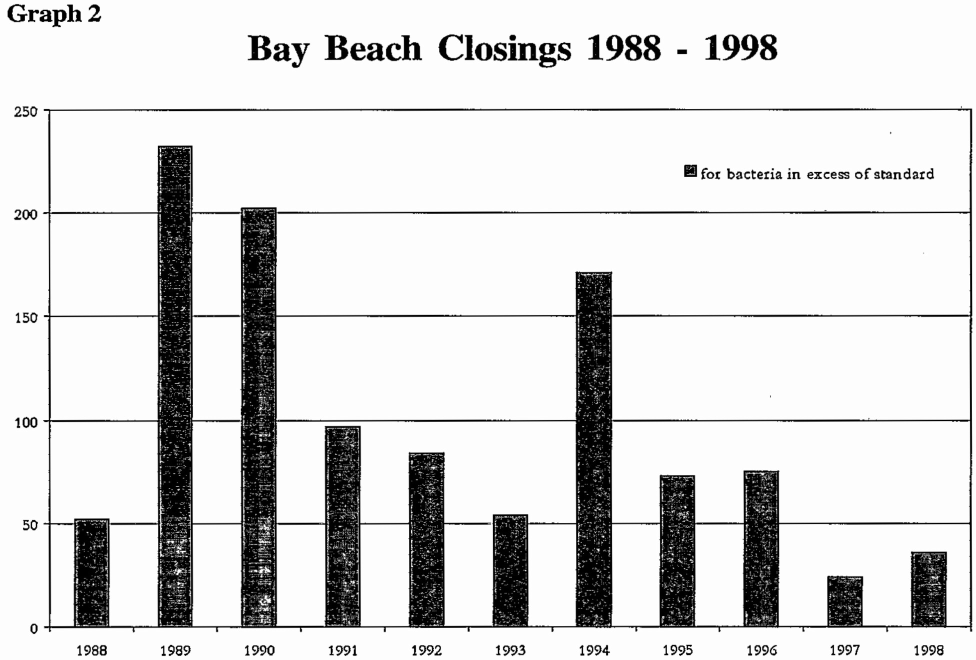
Table 1

Ocean Closings	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
bacteria	784	35	22	10	27	34	50	4	10	18	3
floatables	19	9	10	0	0	0	0	0	0	0	0
total	803	44	32	10	27	34	50	4	10	18	3
Bay Closings	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
bacteria	0	0	0	0	0	0	0	0	0	0	0
floatables	52	232	202	97	84	54	171	73	75	24	36
total	52	232	202	97	84	54	171	73	75	24	36

Graph 1

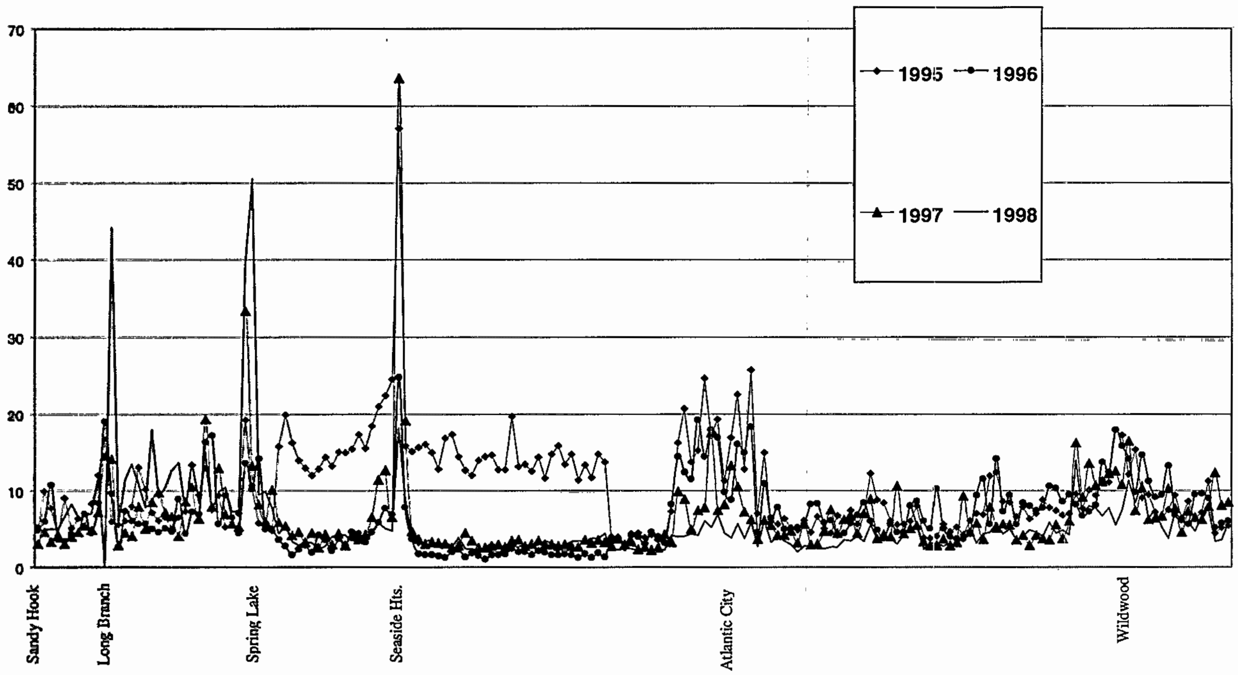


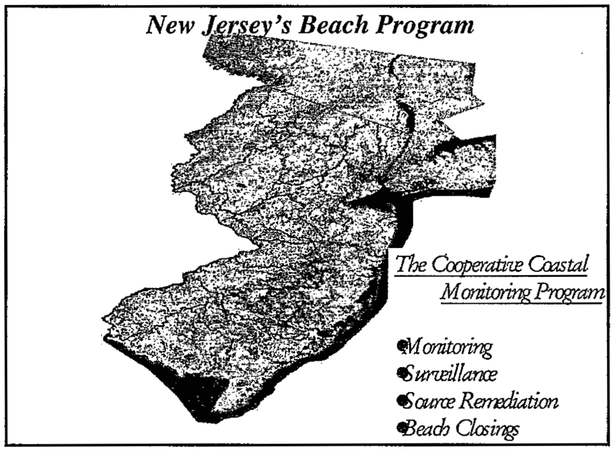
Graph 2

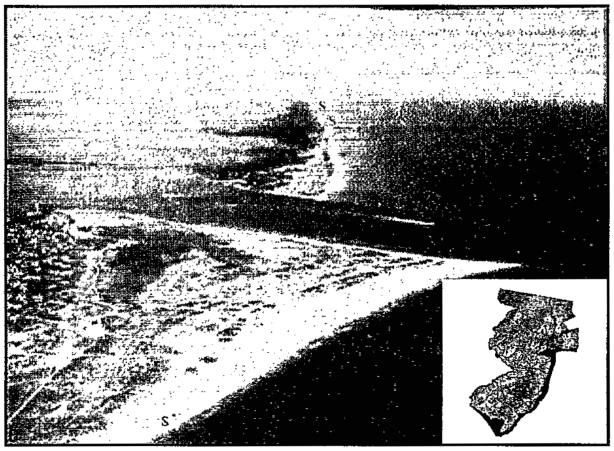


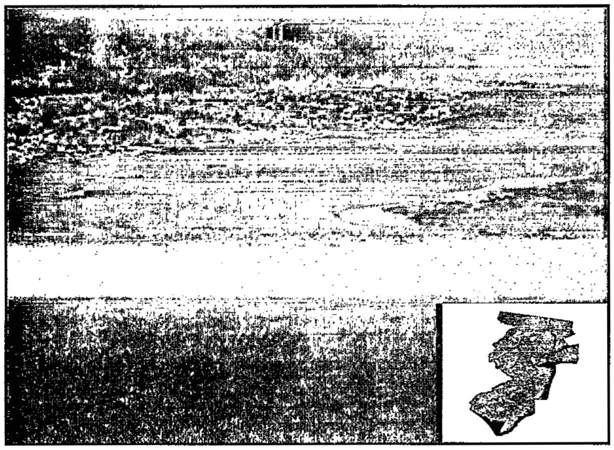
Graph 3

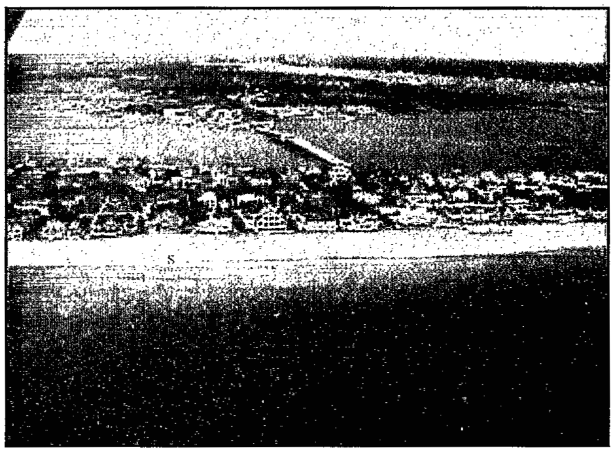
Geometric Means of Fecal Coliform at 179 Ocean Sampling Stations 1995 - 1998

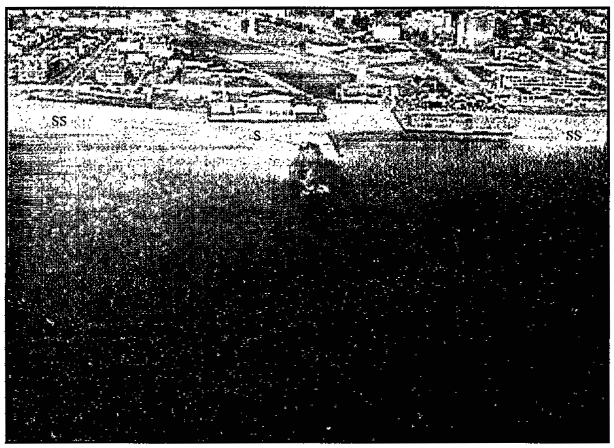


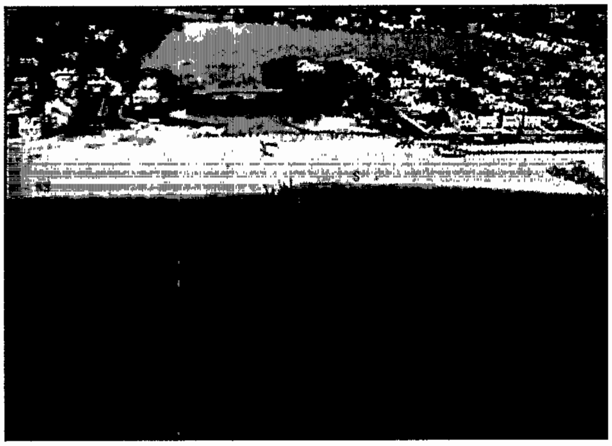

New Jersey's Beach Program
The Cooperative Coastal Monitoring Program
Monitoring
Surveillance
Source Remediation
Beach Closings

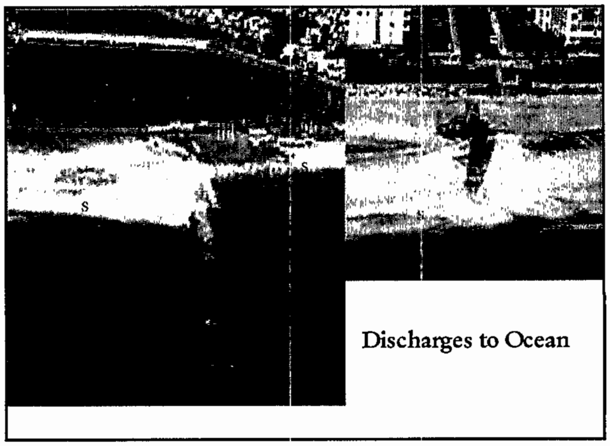


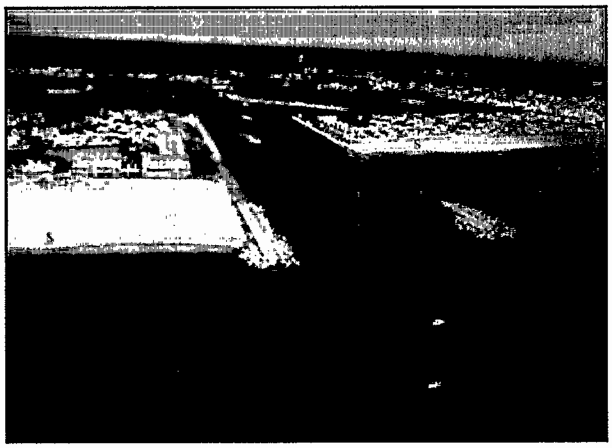


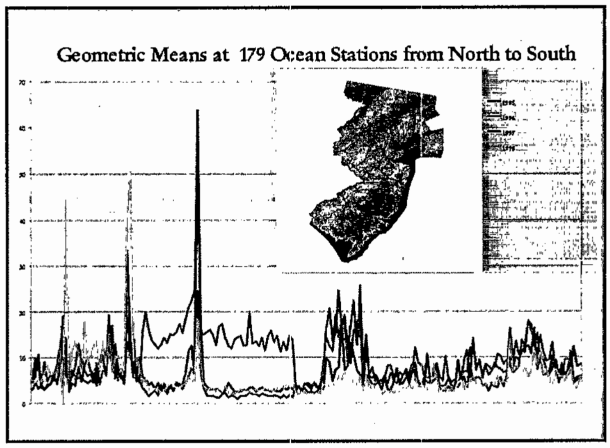


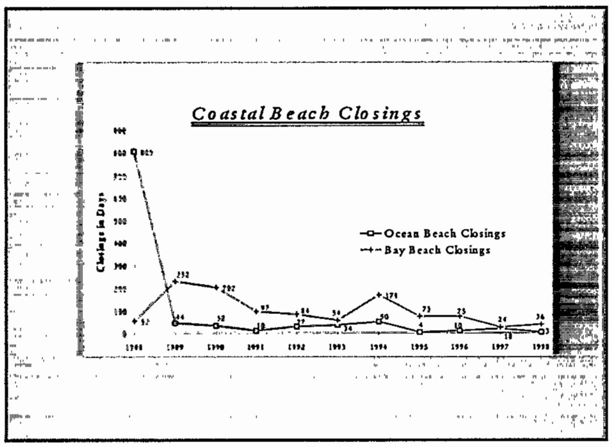


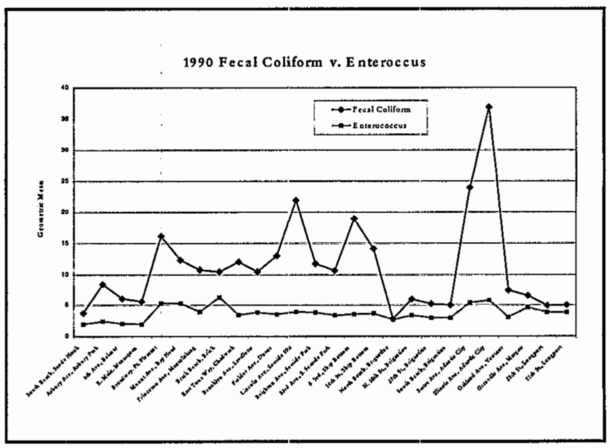


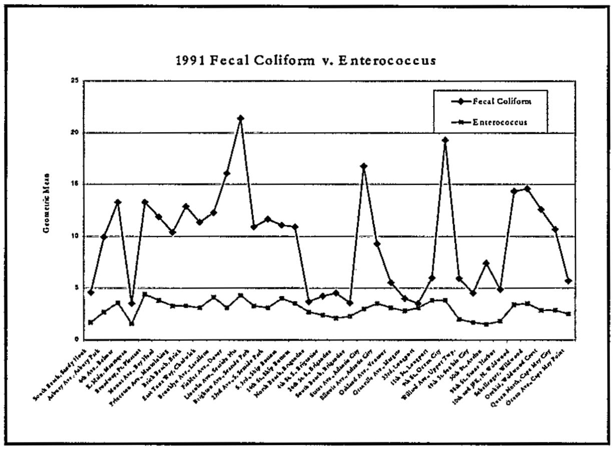

Discharges to Ocean

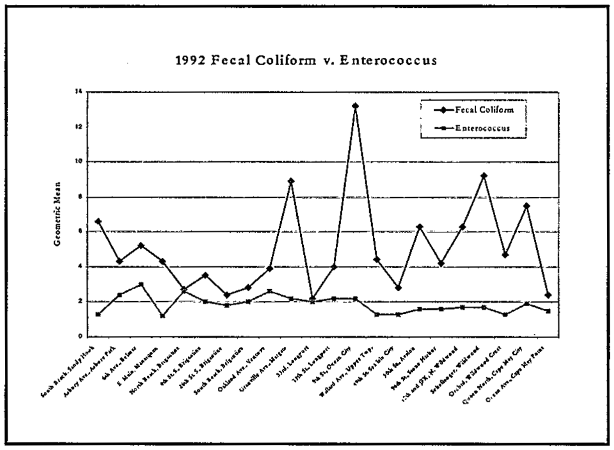


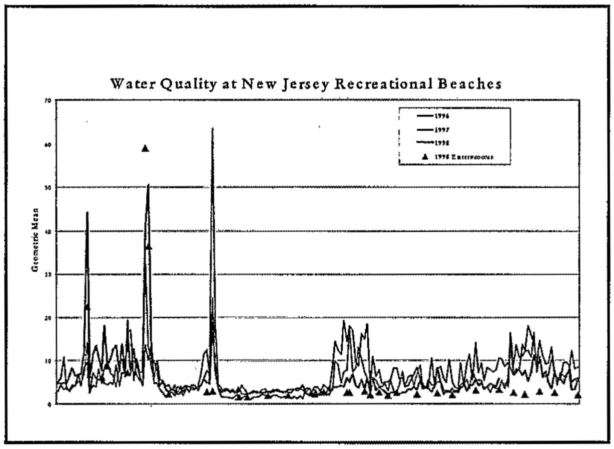

Geometric Means at 179 Ocean Stations from North to South

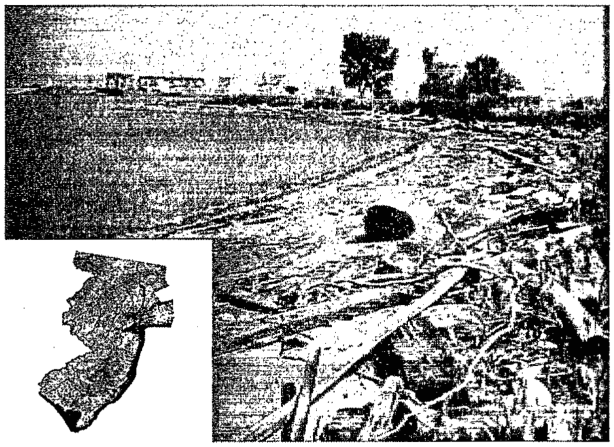

Coastal Beach Closings
Closings in Days
Ocean Beach Closings
Bay Beach Closings

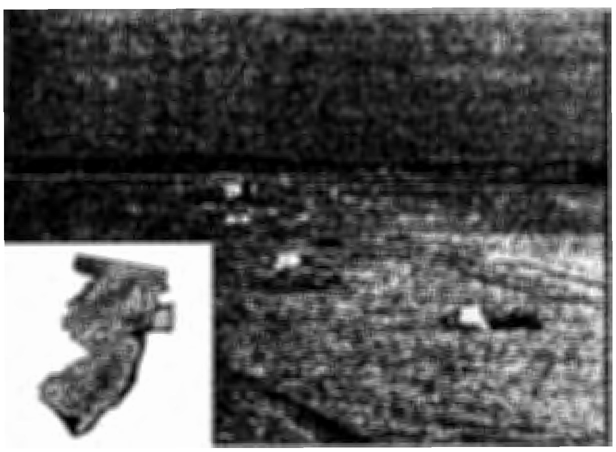

1990 Fecal Coliform v. Enteroccus
Fecal Coliform
Enterococcus
Geometric Mean

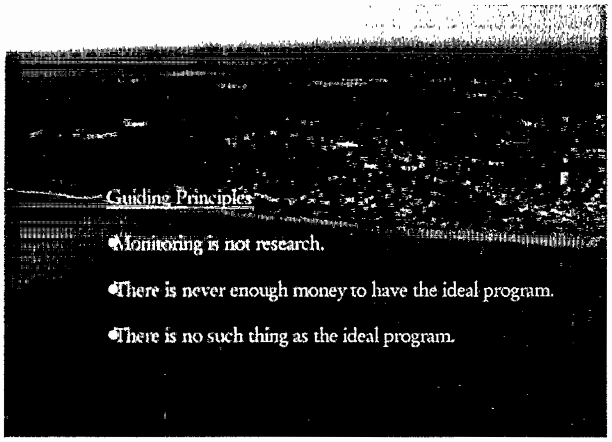

1991 Fecal Coliform v. Enterococcus
Fecal Coliform
Enterococcus
Geometric Mean


1992 Fecal Coliform v. Enterococcus
Fecal Coliform
Enterococcus
Geometric Mean


Water Quality at New Jersey Recreational Beaches
Geometric Mean






Guiding Principles
•Monitoring is not research.
•There is never enough money to have the ideal program.
•There is no such thing as the ideal program.

Monitoring Program at Lake Powell

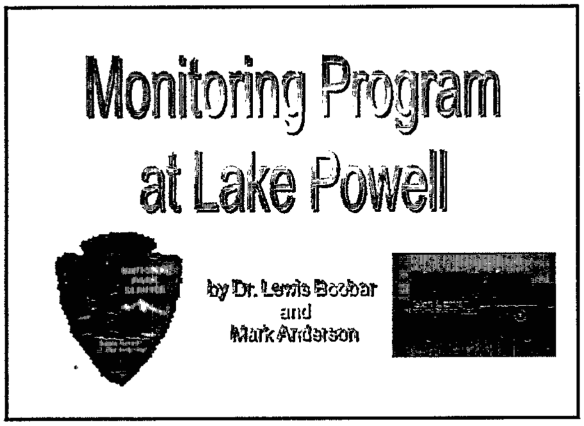
Presented by Mark Anderson for Lewis Boobar
National Park Service, Glen Canyon National Recreation Area

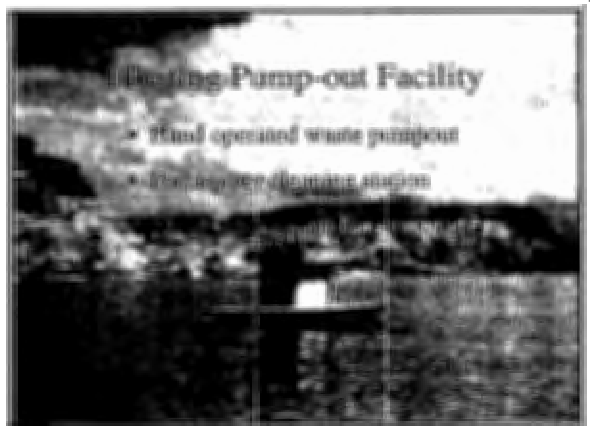
The beach-monitoring program at Glen Canyon National Recreation Area (NRA) began in 1988 to protect visitor health by detecting fecal coliform bacterial contamination that might occur at popular beaches on Lake Powell. Monitoring is conducted at least every other week at approximately 50 sites lakewide. A routine sampling site list is maintained based on historical bacterial counts. Each sampling event also includes at least two randomly determined beaches to increase the program's coverage of the lake. Additional beaches, besides the routine and random beaches, are sampled based on known or suspected problems. Protocols exist to add random or other sampled beaches to our routine sampling schedule. ArcView is used to randomly select beaches. The lake is currently stratified into two areas for sampling. Future plans will stratify the lake into 13 zones, which coincide with visitor use. The two-level stratification system was established to minimize distances between sample sites and the laboratories. The two laboratories are located 112 km apart, one at Wahweap, Arizona, and the other at Bullfrog, Utah. The laboratories are certified with the Utah Department of Health.

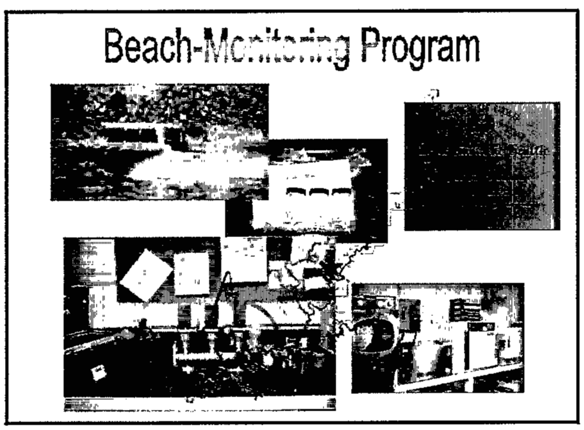
There are two major questions that need to be resolved. The first question is what is the best method for estimating the bacterial population along a beach? The NRA is switching from a single fixed sampling location, which provides us with little information about the bacterial population along the beach, to a random sampling scheme. Although the number of samples is currently limited to three, the arithmetic mean of those samples provides a better estimate of the condition along the beach than a single sample from a fixed location. Random sampling provides a better estimate because the causes of an elevated bacterial count cannot be consistently associated with a single point along a beach. Elevated counts are related to a combination of events, such as weather, beach orientation, drainage, grazing, recreation, and sediment load.

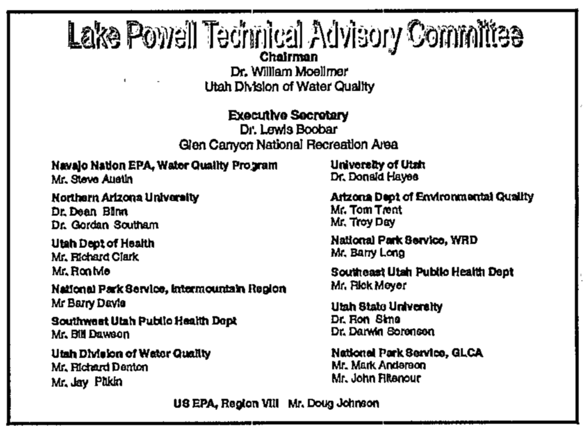
The second question is what is an appropriate beach closure model? The current model at Lake Powell is that re-sampling occurs if 200 colony-forming units (cfu) per 100 mL Membrane Filtration (MF) or 126 Most Probable Number per 100 mL using Colilert® is obtained. If Colilert® is being used, then the method is immediately switched to MF for regulatory purposes. A re-sample count of 200 cfu MF causes closure. The beach remains closed until the 2, 3, 4, and 5-day geometric mean and the last day of sampling are below 200 cfu. The problem is that only 25 percent of the beaches found high on day one are high on day three and only 35 percent of the beaches that are high on day three are high on day four. In other words, 65 percent of the beaches are below 200 cfu on the day the beach is closed. The beach will remain closed for 5 additional days until a 5-day geo-mean below 200 cfu is achieved. Only 8.75 percent of the beaches found high initially are high on day four.

In conclusion, the determination of the threat along a beach should be based on sound statistical sampling methods. The beach closure policy should be conservative in favor of public health; however, the model should also be predictive of pollution events that exist for longer than four days. Closing a beach causes economic loss to the local community due to canceled vacations. Additionally, people recreating are unduly alarmed over a short-term threat, which has corrected itself before any protective action can occur. Development of a meaningful beach closure model is paramount.


Monitoring Program
at Lake Powell
by Dr. Lewis Boobar
and
Mark Anderson


Pump-out Facility


Beach-Monitoring Program


Lake Powell Technical Advisory Committee
Chairman
Dr. William Moellmer
Utah Division of Water Quality
Executive Secretary
Dr. Lewis Boobar
Glen Canyon National Recreation Area
Navajo Nation EPA, Water Quality Program
Mr. Steve Austin
Northern Arizona University
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Dr. Gordan Southam
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National Park Service, Intermountain Region
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Southwest Utah Public Health Dept
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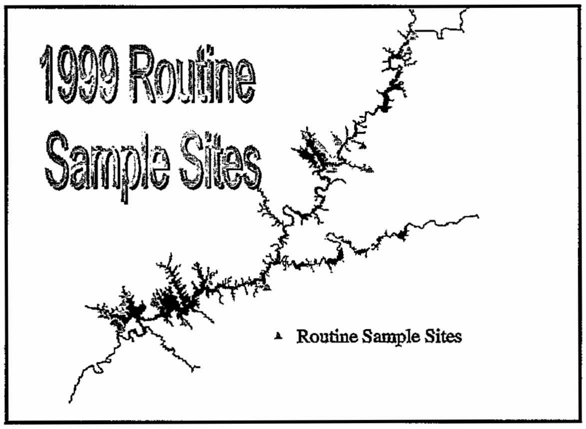
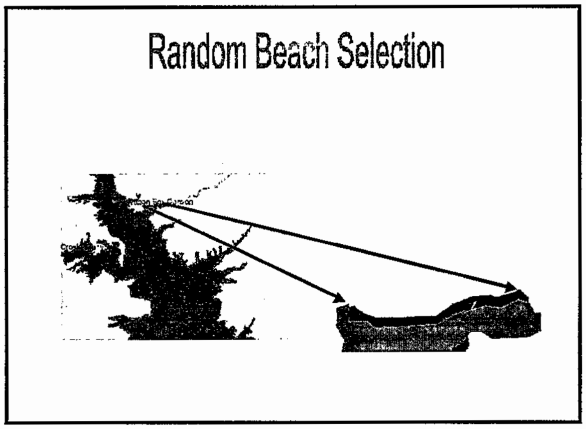
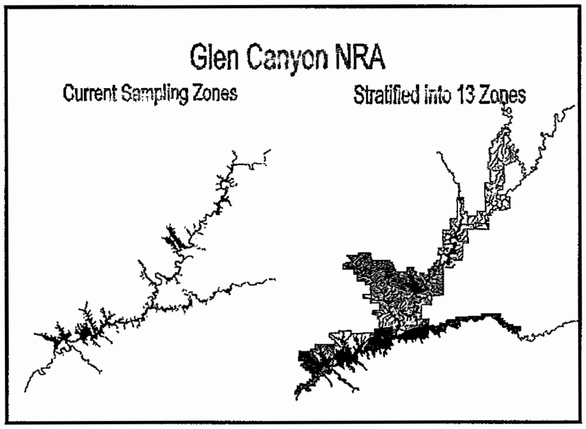
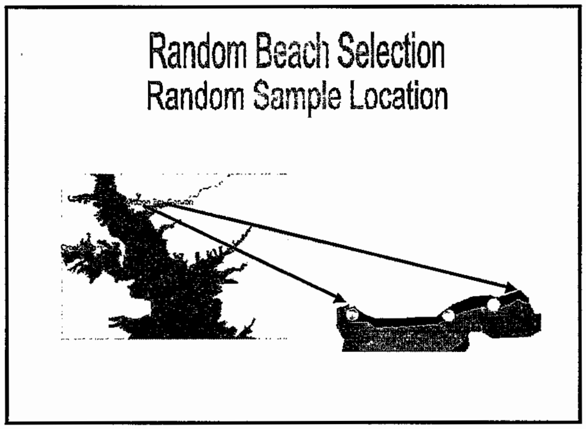
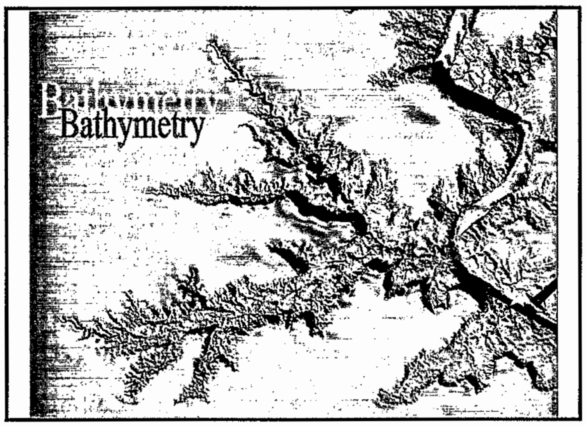
Mr. Barry Long
Southeast Utah Public Health Dept
Mr. Rick Meyer
Utah State University
Dr. Ron Sims
Dr. Darwin Sorensen
National Park Service, GLCA
Mr. Mark Anderson
Mr. John Ritenour
US EPA, Region VIII Mr. Doug Johnson

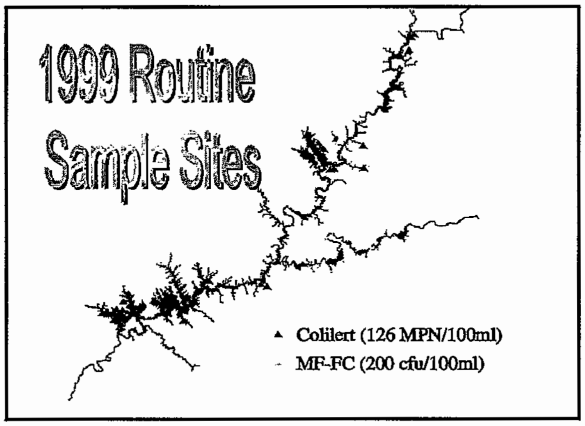

1999 Routine
Sample Sites
Routine Sample Sites

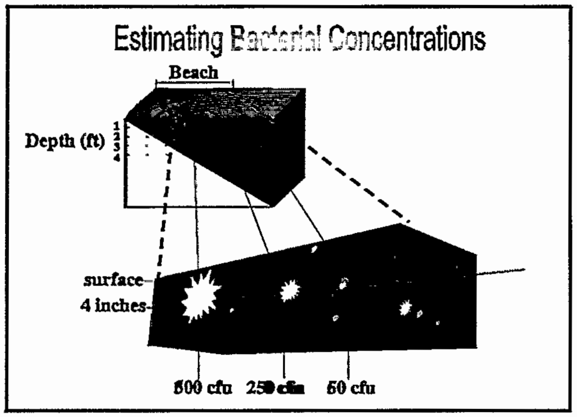

Random Beach Selection


Glen Canyon NRA
Current Sampling Zones
Stratified into 13 Zones


Random Beach Selection
Random Sample Location

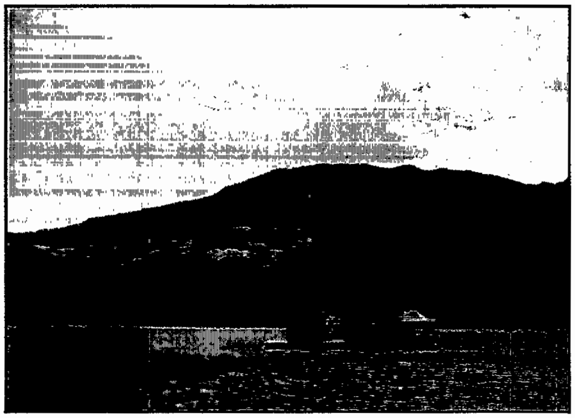

Bathymetry

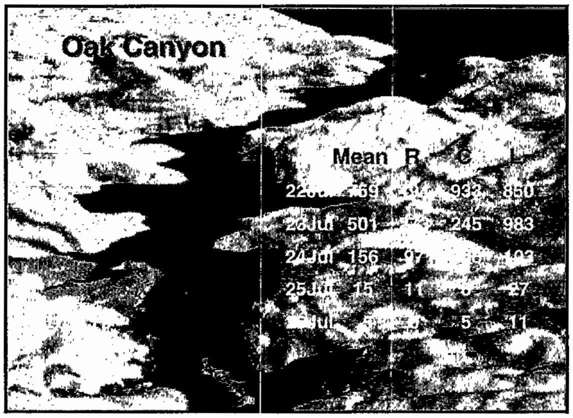

1999 Routine
Sample Sites
Colilert (126 MPN/100ml)
MF-FC (200 cfu/100ml)

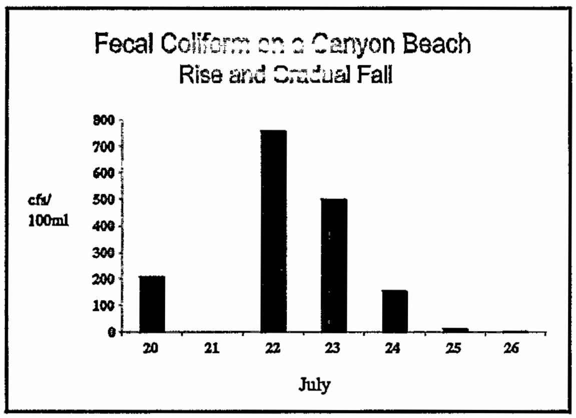


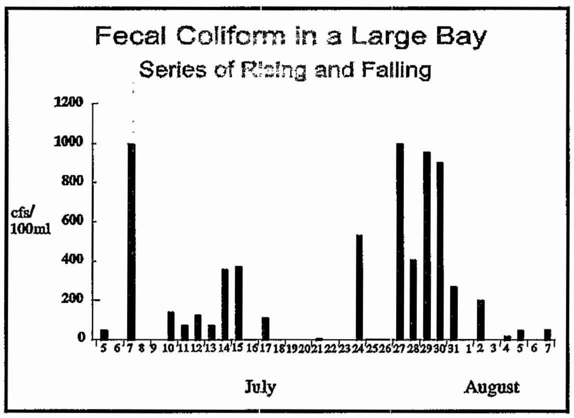
Water Quality Site Resample Event

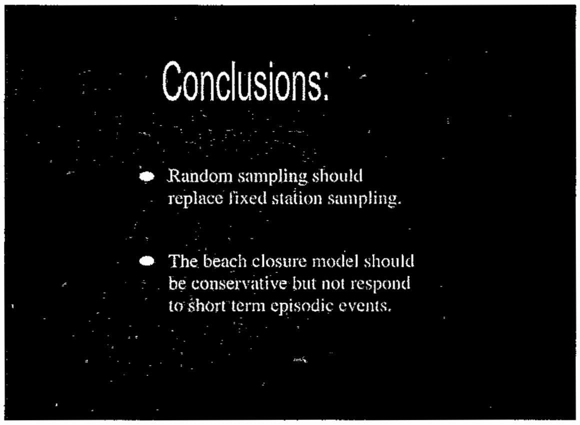
Sample Date	Count Date	Test Method	Bacterial Count	Geometric Mean				Recommended Action
				2-Day	3-Day	4-Day	5-Day	
20 July	21 July	Colilert	209.8	NA	NA	NA	NA	Resample
22 July	23 July	Membrane Filtration	759.1	NA	NA	NA	NA	Closure Resample
23 July	24 July	Membrane Filtration	500.6	616.4	NA	NA	NA	Remain Closed Resample
24 July	25 July	Membrane Filtration	155.9	279.4	389.8	NA	NA	Remain Closed Resample
25 July	26 July	Membrane Filtration	15.3	48.8	106.1	173.5	NA	Remain Closed Resample
26 July	27 July	Membrane Filtration	5.4	9.1	23.4	50.4	86.7	Re-open Beach










Conclusions:
Random sampling should replace fixed station sampling.
The beach closure model should be conservative but not respond to short term episodic events.

California's Regulations and Guidance for Beaches and Recreational Waters

Steven Book
California Department of Health Services, Division of Drinking Water and Environmental Management

The Department of Health Services (DHS) recently expanded its regulations for public beaches and ocean water-contact sports areas in response to requirements of Health and Safety Code §115880, Assembly Bill (AB) 411, Statutes of 1997, Chapter 765. The regulations (in Title 17 of the California Code of Regulations) consist of §7956 (new), §7958 (amended), §7961 (new) and §7962 (new), which became effective July 26, 1999. Other regulations, §7957, §7959, and §7960, were unchanged. The regulations are reproduced below.

7956. Storm Drain. "Storm drain" means a conveyance through which water flows onto or adjacent to a public beach and includes rivers, creeks, and streams, whether in natural or in man-made channels.

7957. Physical Standard. No sewage, sludge, grease, or other physical evidence of sewage discharge shall be visible at any time on any public beaches or water-contact sports areas.

7958. Bacteriological Standards. (a) The minimum protective bacteriological standards for waters adjacent to public beaches and public water-contact sports areas shall be as follows:

(1) Based on a single sample, the density of bacteria in water from each sampling station at a public beach or public water-contact sports area shall not exceed:

(A) 1,000 total coliform bacteria per 100 milliliters, if the ratio of fecal/total coliform bacteria exceeds 0.1; or

(B) 10,000 total coliform bacteria per 100 milliliters; or

(C) 400 fecal coliform bacteria per 100 milliliters; or

(D) 104 enterococcus bacteria per 100 milliliters.

(2) Based on the mean of the logarithms of the results of at least five weekly samples during any 30-day sampling period, the density of bacteria in water from any sampling station at a public beach or public water-contact sports area, shall not exceed:

(A) 1,000 total coliform bacteria per 100 milliliters; or

(B) 200 fecal coliform bacteria per 100 milliliters; or

(C) 35 enterococcus bacteria per 100 milliliters.

(b) Water samples shall be submitted for bacteriological analyses to a laboratory certified in microbiology by the California Department of Health Services, Environmental Laboratory Accreditation Program, for methods for the analysis of the sample type.

7959. Bacteriological Sampling. (a) In order to determine that the bacteriological standards specified in Section 7958 above are being met in a water-contact sports area designated by a Regional Water Quality Control Board in waters affected by a waste discharge, water samples shall be collected at such sampling stations and at such frequencies as may be specified by said board in its waste discharge requirements.

(b) In waters of a public beach or water-contact sports area that has not been so designated by a Regional Water Quality Control Board, water samples shall be collected at such frequencies as may be determined by the local health officer or Department. Local health officers shall be responsible for the proper collection and analysis of water samples in such areas.

7960. Corrective Action. (a) When a public beach or public water-contact sports area fails to meet any of the standards as set forth in Section 7957 or 7958 above, the local health officer or the Department, after taking into consideration the causes therefor, may at his or its discretion close, post with warning signs, or otherwise restrict use of said public beach or public water-contact sports area, until such time as corrective action has been taken and the standards as set forth in 7957 and 7958 above are met.

7961. Public Beaches Visited by More than 50,000 People Annually and Adjacent to Storm Drains. (a) Waters adjacent to a public beach shall be tested for bacteria identified in Section 7958 on at least a weekly basis from April 1 to October 31, inclusive, if the beach is

(1) Visited by more than 50,000 people annually, and

(2) Located adjacent to a storm drain that flows in the summer.

(b) Water samples shall be taken from locations that include areas affected by storm drains. Samples shall be taken in ankle- to knee-deep water, approximately 4 to 24 inches below the water surface.

(c) When testing reveals that the waters adjacent to a public beach fail to meet any of the standards set forth in Section 7958(a)(1), the local health officer shall post the beach pursuant to Health and Safety Code Section 115915, and shall use the standards of Sections 7958(a)(1) and (2) in determining the necessity to restrict the use of or close the public beach or portion thereof.

(d) In the event of a known release of untreated sewage into waters adjacent to a public beach, the local health officer shall:

(1) Immediately post and close the beach or a portion thereof, or otherwise restrict its use until the source of the sewage release is eliminated;

(2) Sample the affected waters; and

(3) Continue closure or restriction of the beach or a portion thereof and posting the beach until testing results establish that the standards of Sections 7958(a)(1) are satisfied.

7962. Duties Imposed on a Local Public Officer or Agency. (a) Pursuant to Health and Safety Code Sections 115880(h), 115885(g), and 115915(c), any duty imposed upon a local public officer or agency by Section 7961 shall be mandatory only during a fiscal year in which the Legislature has appropriated sufficient funds, as determined by the State Director of Health Services, in the annual Budget Act or otherwise for local agencies to cover the costs to those agencies associated with performance of these duties.

DHS also prepared draft guidance documents for local health departments seeking to improve their programs for both saltwater and freshwater beaches and recreational waters. These guidance documents are available from the DHS Web site.

For more information: http://www.dhs.ca.gov/ps/ddwem/beaches/beachesindex.htm

California's Regulations and Guidance for Beaches and Recreational Waters

Steven Book, Ph.D.
Division of Drinking Water
and Environmental Management
California Department of Health Services
August 31, 1999
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AB 411 [(Statutes of 1997, Chapter 765), amended Health and Safety Code Sections 115880, 115885, and 115915)] requires DHS to develop regulations:

- Standards for three indicator organisms for all public beaches:
  - Total coliforms
  - Fecal coliforms
  - Enterococcus
- Procedures for closing and posting public beaches that are
  - Adjacent to storm drains that flow during the summer
  - Visited by 50,000 visitors
  - Coastal (not within San Francisco Bay)
- Implementation not required if legislature does not provide adequate funding in the annual budget. (~ $1 million is in annual budget)

Standards for Microbiological Indicators

The most recent single measurement is to be used for determining the need for beach posting.

- Total coliform bacteria: 1,000 per 100 milliliters, if the fecal/total ratio exceeds 0.1.
- Total coliform bacteria: 10,000 per 100 milliliters.
- Fecal coliform bacteria: 400 per 100 milliliters.
  - Enterococcus bacteria: 104 per 100 milliliters.

Microbiological Standards (cont)

The 30-day average of measurements of the level (the log mean of the results of 5 weekly samples) is to be used by the local health officer along with the single sample standards to determine if closing and/or other restrictions are appropriate.

- Total coliform bacteria: 1,000 per 100 milliliters
- Fecal coliform bacteria: 200 per 100 milliliters
- Enterococcus bacteria: 35 per 100 milliliters

Locations, Frequency, & Depth of Sample Collection

For AB 411 public beaches

- At least weekly sampling from April 1 to October 31
- Sampling is to include waters affected by storm drains
- Samples to be taken in ankle- to knee-deep water, approximately 4 to 24 inches below the water surface

For others: At the discretion of the local health officer.

Definitions

Storm drain (Regulation): A conveyance through which water flows onto or adjacent to a public beach, and includes rivers, creeks, and streams, whether in natural or in man-made channels.

Definitions (cont)

Posting: Signs at an area of a public beach that inform the public of contamination of recreational water and the risk of possible illness (AB411).

Posting may be (1) temporary, when a single standard is exceeded for a short period, or (2) more permanent, where monitoring indicates regular or sporadic contamination (e.g., storm drain), or where contamination sources are identifiable and can be explained (e.g., storm drain water, or residential marine mammals or seabirds) (Guidance).

Posting is required at public beaches subject to AB411 whenever standards for microbiological indicator organisms are exceeded.

Definitions (cont)

Closure (Guidance): Signs that inform the public that the beach area is closed to swimming and water contact. They should indicate the nature of the concern (e.g., sewage spill), and should, by language, color, and design, enable differentiation from advisories provided by posting.

Closure is envisioned to occur when health risks are considered greater than those associated with posting, as with sewage spills or at areas at which monitoring results show that multiple indicator organism standards are exceeded, for both single sample and 30-day average values.

Closure is required by AB 411 when an untreated sewage release is known to have reached recreational waters at a public beach.

Beach Is Required To Be Closed...

- with a known release of untreated sewage (AB 411)
- otherwise at the discretion of the local health officer

Beach Is Required To Be Posted With Warning Signs...

- whenever an applicable standard is exceeded (AB 411)
- otherwise at the discretion of the local health officer

Sample Language For Signs (Guidance)

WARNING!
Untreated Sewage Spill
Beach Closed

WARNING!
Storm Drain Water May Cause Illness
No Swimming In Storm Drain Water

Other Means of Public Information

- Telephone Hotline (required by AB 411)
- Press Release (Guidance)
- Electronic Access (e.g., Internet or local television) (Guidance)

Future Activities

- Freshwater beaches and certain other beaches
- Reporting of beach closures/postings (SWRCB)

For More Information:

Regulations for implementing AB411

Guidance documents for saltwater and freshwater beaches

Can be accessed via:

http://www.dhs.ca.gov/ps/ddwem/beaches/beachesindex.htm

Southern California Bight 1998 Regional Monitoring Program: Summer Shoreline Microbiology

Charles McGee
Orange County Sanitation District

Noble, R.T.[1,2], J.H. Dorsey[3], M.K. Leecaster[1], M. Mazur[4], C.D. McGee[5], D. Moore[6], V. Orozco-Borbon[7], D. Reid[8], K. Schiff[1], P.M. Vanik[9], and S.B. Weisberg[1] (alphabetical order)

[1] Southern California Coastal Water Research Project; [2] Wrigley Institute for Environmental Studies, University of Southern California; [3]City of Los Angeles, Stormwater Management Division; [4]Orange County Environmental Health Division; [5]Orange County Sanitation District; [6]Orange County Public Health Laboratory; [7]Instituto de Investigaciones Oceanologicas, Universidad Autonoma de Baja California; [8]Santa Barbara County Public Health Department; [9]City of San Diego Metropolitan Wastewater Department

More than 80,000 shoreline bacteriological samples are collected annually in southern California, representing roughly one-half of the total bacteriological monitoring conducted in the United States. Despite this impressive amount of monitoring, these data are difficult to integrate for the purpose of making a regional assessment of water quality. Integration is difficult because the data are collected by 22 different organizations with different sampling strategies and different data management systems. Additionally, because the sample locations are assigned to focus on known "problem areas" or to comply with a specific monitoring objective, the strategy does not allow for an assessment of typical regional shoreline microbiological water quality. To overcome these limitations, all of the organizations that perform routine monitoring in the Southern California Bight (SCB) conducted an integrated survey during the summer of 1998 that assessed the overall microbiological water quality of the southern California shoreline. The primary goals of the survey were:

- To determine the percent of shoreline mile-days in the SCB that exceeded bacterial indicator thresholds during August of 1998;
- To compare the response among three bacterial indicators commonly used in California; and
- To determine how well these bacterial indicator measures correlated with detection of human enteric virus genetic material.

Samples were collected on a weekly basis at 307 sites between Point Conception, California, and Punta Banda, Mexico, beginning August 1, 1998, and continuing for five weeks. Sampling sites were selected using a stratified random design. Strata included high- and low-use sandy beaches, high- and low-use rocky shoreline, ephemeral freshwater outlets and perennial freshwater outlets. Samples were collected according to standardized protocols. Total and fecal coliform were measured in all samples. Enterococci were measured in approximately 70 percent of the samples. Molecular analyses to detect the presence of human enteric virus genetic material were performed on samples collected from 15 randomly selected perennial freshwater outlets. Analysis for the presence of this genetic material was used as a tool to detect human fecal contamination in the coastal zone. It was not intended to be used to infer health risk.

Prior to starting the project, the 22 participating laboratories conducted intercalibration studies to assess data comparability. Thirteen common samples were analyzed by each laboratory to define variability among laboratories, within laboratories, and among methods. Three quantitative analytical methods, multiple tube fermentation (MTF), membrane filtration (MF), and chromogenic substrate tests in a most probable number format were compared for total coliform, fecal coliform (or *E. coli)*, and enterococci. The average difference among methods was less than 6 percent. The average difference among laboratories was less than 2 percent. The greatest source of variability was among replicates within individual laboratories. The intercalibration exercises demonstrated that a multi-laboratory, performance-based approach was acceptable for implementing this regional study.

Overall, microbiological water quality along the southern California shoreline was good during the study period with more than 95 percent of the shoreline mile-days meeting all present and proposed California bacterial indicator standards. In 98 percent of the cases where a standard was exceeded, it was exceeded for only one bacterial indicator, while all other bacterial indicators at the same site and at the same time were below thresholds. Less than 0.2 percent of the shoreline mile-days exceeded thresholds for all indicators measured at the site.

Freshwater outlets failed to meet bacterial indicator standards in almost 60 percent of the samples, the worst of all strata. Most of the standard failures near freshwater outlets were for multiple indicators and occurred repetitively throughout the five-week study period. Molecular tests demonstrated the presence of human enteric virus genetic material in 7 of the 15 freshwater outlets with 73 percent of these detections coinciding with levels of fecal coliform that exceeded bacterial indicator thresholds.

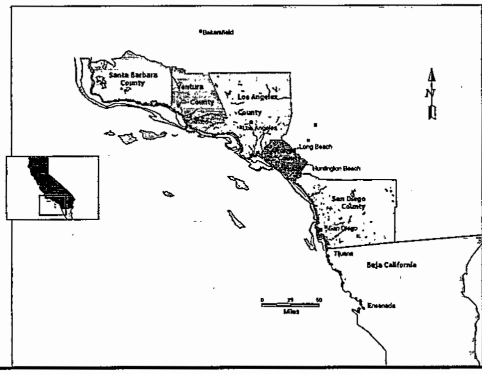
The probability of exceeding a bacterial indicator threshold differed substantially among indicators. Of the samples that exceeded a bacterial standard, and for which all three indicators were measured, only 13 percent failed for all three indicators, 34 percent failed for two indicators, and 54 percent failed for one indicator. Thresholds for fecal coliform were exceeded at twice the rate of total coliform, and enterococci failed at three times the rate of total coliform. Less than one-half of the enterococci thresholds failures paired with threshold failures by another indicator, while nearly 90 percent of the total and fecal coliform threshold failures were partnered with failures of another indicator.

This cooperative study is the first to compare the relative quality of Mexican and United States beaches using similar site selection approaches and coordinated quality assurance methods. Although nearly 75 percent of the beach samples in Mexico met California's bacteriological water quality standards, the standards were exceeded five times more often on Mexican than on United States beaches. Mexican freshwater outlets were just as likely to exceed a bacteriological water quality standard as those in the United States.

1998 Southern California Microbiological Survey

Charles D. McGee
Orange County Sanitation District

SOUTHERN CALIFORNIA BIGHT



Background: Existing Effort (Annually)

- 22 agencies conduct monitoring at 542 sites
- 82,310 bacteriological analyses:
  - *Shoreline = 64,134*
  - *Offshore = 18,176*
- About $3 million/year spent

Existing Effort (cont)

- Focused upon areas designated as problem areas (near storm drains)
- Potentially impacted by offshore discharges (NPDES permit required)

Limitations: Existing Efforts

- Sites are not randomly assigned
- Area monitored is only 7% of the entire shoreline
- No common analytical method
- No common database

Consequence

- Assessment of the entire coastal area not possible

Participants

- Aliso Water Mgmt Authority
- Aquatic Bioassay & Consult.
- City of Long Beach
- City of Los Angeles
- City of Oceanside
- City of Oxnard
- City of San Diego
- City of Santa Barbara
- City of Ventura
- Encina W.W. Auth.
- Goleta Sanitation District
- Heal the Bay
- UABC
- LA Co Beaches & Harbors
- LA Co Dept Hlth Serv.
- Los Angeles RWQCB
- LA Co Sanitation Districts
- USMC Camp Pendleton
- Orange Co Env Hlth Div
- Orange Co Sanitation District
- San Diego Co Dpt Env Health
- San Diego RWQCB
- San Elijo Jt Powers Authority
- Santa Barbara Hlth Care Ser
- SE Reg. Reclamation Auth
- So Cal Cstl Wat Res Project*
- So Calif Marine Inst
- Surfrider Foundation
- SWRCB
- USC

* Coordinating group

Objectives

- Determine the percent of shoreline meeting bacterial water quality standards
- Compare indicator bacterial levels among types of shoreline
- Assess association between runoff and virus

Percent of Shoreline Meeting Bacterial Water Quality Standards

What percent of beach-mile days exceed *[indicator]* threshold limits during *[season]* at *[geographical area]*?

Indicators: *total coliform, fecal coliform, enterococci*

Season: *Summer 1998*

Areas: *accessible shoreline, freshwater outlets*

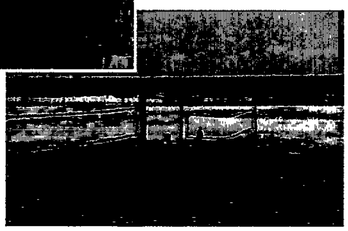
Geographical Areas

Sandy Beaches
High-use (lifeguard service)
Low-use (no lifeguard service)

Rocky Shoreline
High-use (popular dive and surf spots)
Low-use (little or no diving or surfing)

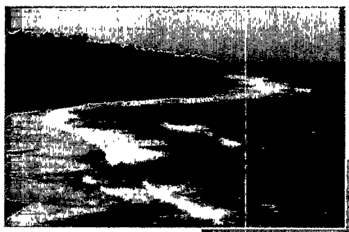
Freshwater Outlets
Ephemeral
Perennial
Point Zero

HIGH-USE SANDY BEACHES

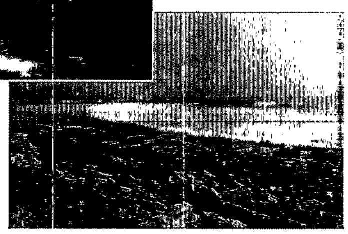



Manhattan Beach

HIGH-USE ROCKY BEACHES

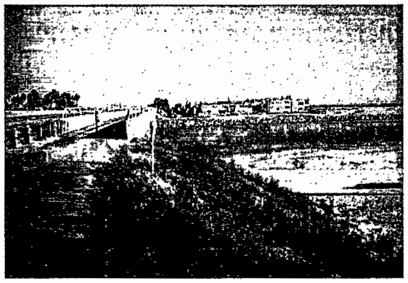


Bluff Cove, Rancho Palos Verdes



Pt. Fermin, San Pedro

Freshwater Outlets Storm Drain/Channel



Basic Design Elements

- Recreational shoreline, freshwater outlets (81) mapped in GIS database
- Fixed sites randomly selected among strata
- Two types of site placement at outlets:
  - » Randomly, within 100 yards
  - » Fixed, at mouth of outlet ("Point Zero" sites)
- 213 southern California, 29 Mexico
- Sites sampled weekly August - September 1998
- All participating laboratories had to perform intercalibration studies

Intercalibration Exercises

- Analyze 13 common samples
- Three to five replicates
- Use standard analytical procedures
- Use their standard quality assurance procedures
- Report data in a common format

Goals of Intercalibration

- Quantify and compare:
  - » within laboratory variance
  - » among laboratory variance
  - » among analytical methods

Analytical Method Enumeration

- Membrane filtration (MF)
- Multiple tube fermentation (MTF)
- Chromogenic substrate in the most probable number (MPN) format

Analytical Methods

- Total coliform by
  - » M-Endo (MF)
  - » LTB/BGB (MTF)
  - » Colilert®

Analytical Methods

- Fecal coliform
  - » M-FC (MF)
  - » EC
  - » A-1
  - » Colilert®

Analytical Methods

- Enterococci
  - » Method 1600 & mE agar (MF)
  - » Enterolert®
  - » Azide dextrose broth/Pfizer selective enterococcus agar with confirmation in brain-heart infusion broth containing 6.5% NaCl @45° C

Intercalibration Results

- Between-laboratory
  - » significant difference was seen in only 7% of all pairwise comparisons between laboratories
  - » largest difference between laboratories was 29%
  - » average difference <2%

Intercalibration Results

- Between-laboratory
  - » differences occurred most frequently for total coliform (10%)
  - » least frequently for fecal coliform (3%)
  - » greatest variability for MTF
  - » least for MF

Intercalibration Results

- Between methods
  - » average difference was <6%
  - » biggest difference measured in low range of fecal coliform by MF *(may have been due to clumping)*

Intercalibration Results

- Between methods
  - » Only consistent difference was found with Enterolert® *(at low densities no difference, but at high densities underestimated concentration by 5% relative to other methods)*

Intercalibration Results

- Within laboratory
  - » largest source of variability in the survey
  - » values typically 1/3 to 3 times the median

Intercalibration Results

- Within laboratory
  - » smallest variance with MF

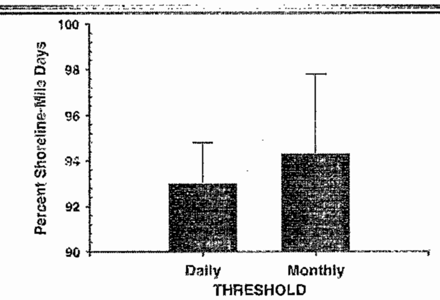
Coordinated studies with Mexico

- **Measured total and fecal coliform using MTF**
- **29 sites**
  - » **19 along sandy beaches**
  - » **10 at perennial water outlets**
- **Results provided international comparison, paved way for cooperative work**

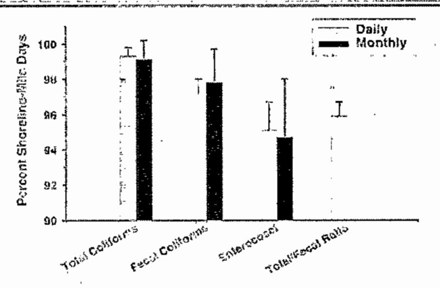
Indicator Thresholds (AB 411 & Ocean Plan)

Indicator	Daily Limits	Monthly Limits
Total coliform	10,000	20% > 1,000
Fecal coliform	400	200 (G.M.)
Enterococci	104	35 (G.M.)
Total/Fecal Ratio	When TC > 1,000 and TC/FC ≥10	and TC/FC ≥5

Shoreline Water Quality in the SCB during Aug. 1998 Meeting Standards



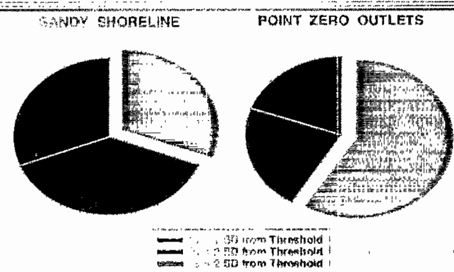
Shoreline Water Quality By Indicator



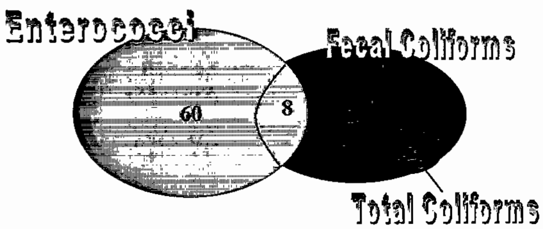
Shoreline Water Quality by Strata

	% SMD Exceeding Threshold	
	Daily	Monthly
High use sandy	7.8	9.6
Low use sandy	4.1	0.0
High use rocky	2.4	2.8
Low use rocky	2.1	9.4
Ephemeral outlets	7.3	6.7
Perennial outlets	10.9	13.5
Point Zero	40.0	58.3
All SCB	4.9	5.7

Magnitude of Exceedence



Indicator Threshold Exceedence



Frequency of Threshold Exceedences In Mexico and the United States

STRATA	TOTALS	FECALS	T:F<10
Sandy Beaches:			
Mexico	2.6	25.3	16.5
US	0.5	5.3	2.1
Point Zero:			
Mexico	12.7	32.7	21.8
US	12.0	24.8	21.8

Conclusions

Good shoreline water quality in So. Calif. during summer 1998

About 95% of shoreline-mile days were below thresholds

Worst water quality associated with freshwater outlets

40% of shoreline-mile days were below thresholds and human enteric viruses were detected at half of the outlets measured

Conclusions

Enterococci exceeded thresholds more frequently than any other indicator

Triple the frequency of total coliforms

Mexican beaches exceeded thresholds more frequently than US beaches

Frequency was similar near freshwater outlets

Existing beach monitoring programs and cooperative studies, including use of volunteers, are effective

Went so well we did a "wet season" study!

Conclusions

Bacterial indicators are weakly correlated to one another
Enterococcus is the most conservative of the three

Threshold exceedances by indicators are not tightly related
Most exceedances were for a single indicator

Only storm drains demonstrated multiple indicator exceedances
More than one indicator exceedance per sampling

Acknowledgements

John Dorsey, Molly Leecaster, Monica Mazur, Charles McGee, Douglas Moore, Victoria Orozco-Borbon, Daniel Reid, Ken Schiff, Patricia Vainik, and Stephen Weisberg

Question-and-Answer Session

Panel: David Rosenblatt, Mark Anderson, Charles McGee, and Steven Book

Q (Patty Vainik, City of San Diego, Metropolitan Wastewater Department): Ten years ago, New Jersey did an epidemiological survey along the coastline. I saw a draft final report and I never saw a final report. Did it ever come out?

Dave Rosenblatt:

Yes.

Q (Patty Vainik): Did I miss it in Mr. Gray's presentation? Was it mentioned? Can you tell us the upshot of the report? As I recall, the draft report did not find any significant relationship between any of the indicators, including enterococcus, and incidence of illness. As I remember, just being on the beach, not necessarily swimming, was the predisposing factor to illness.

Dave Rosenblatt:

The study found that there was no more risk of getting ill from swimming than from being on the beach. It also found that bacteria counts in the water were so low that it was very hard to do the study. The Department of Health conducted the study; my department, the Department of Environmental Protection, assisted with monitoring. The conclusion was positive for us. Why people were getting ill just being on the beach, I don't know. There are many theories, including the food that they were eating, bathrooms, etc.

Comment (Mark Gold, Heal the Bay): In regards to the New Jersey Study, they evaluated eight or more beach locations. To do an epidemiological study with that many locations, you need to do interviews with 50,000 or more people. That would have added an unbelievable amount of cost onto the study. This guided the Santa Monica Bay study.

Q (Mark Gold): In regards to AB411, in talking with the various agencies conducting the monitoring, one of the main issues that Department of Health Services needs to address is where to collect the sample in proximity to a storm drain. There are some counties, like San Diego and Santa Barbara counties, that collect samples at point zero or right in front of the drain. Other counties collect samples 25 yards away from the storm drain. I think that the intent of AB411 was to create an even playing field throughout California. At the end of the emergency period, is the state health department considering providing guidance in regards to this issue?

Steven Book:

The effective period of AB411 runs from April through October. I think that we will probably gather the various county representatives and talk about their needs prior to next spring's implementation. The only thing that we have talked about in the regulations, in terms of location of sampling, is that it needs to include waters affected by storm drains. We have not identified exactly those exact distances yet. We have left that up to the discretion of the local health officer. If we do anything outside the regulation, we might make some suggestions in our guidance. However, I don't think that we will do anything right away. We will talk to people and consider additional guidance by next spring.

Dave Rosenblatt:

I just wanted to add to my last answer that there was a delay between the issuance of the draft and final report in 1988. The draft and the final reports were very similar and there was nothing new in the final report. People should know that we did this epidemiological study under extreme duress. Back then, there was public outcry about the alleged quality of our waters because of a primary sewage treatment plant. This plant caused a lot of the beach closings.

Q (Jack Petralia, Los Angeles County Department of Health Services): I feel that freshwater bathing areas present a bigger problem then marine environments because of poor circulation and bathing load. When you get high counts, have you tried to correlate that with bathing load?

Mark Anderson:

It is generally our higher use areas that have been sampled over the years. When we take samples, we make an estimate of the number of people and boats present. We have found no correlations between that and our counts over the past 11 years.

Q (Charles Kovatch, USEPA Office of Science and Technology): Steven Book, you mentioned that for beach advisory and closing postings you allowed flexibility for language, shape, and color of the signs in AB411. Why did you select a flexible approach as opposed to the standardized approach?

Steven Book:

We spent a couple of years meeting with many of the local environmental health directors. At one point, there was a suggestion for common language. Then they realized that many of the signs from various counties differed by one word or by the placement of the no swimming symbol. The county that didn't have the signs that exactly fit the regulation would have to go though all kinds of effort in getting new signs. What we wanted was (1) information to get to the public and (2) incorporate existing signage in counties that already had existing programs.

Q (Fred Lee, G. Fred Lee Associates): Are there any developments toward applying the AB411 approach to the Sacramento River or the Delta? Places where you don't have beaches by strict definition, but you have a lot of swimming, personal watercraft, and skiing.

Steven Book:

With regard to freshwater beaches, it is left up to the county ordinances. The definition of a public beach has changed with the implementation of AB411—it has taken out freshwater beaches—so we need some legislative authority to consider freshwater beaches in regulation. I think that the state board's microbiological numbers are addressed in the ocean plan, but I don't think the board has microbiological standards for freshwater. Freshwater beaches and recreational waters are currently addressed in our draft guidance.

Q (Ken Burger, East Bay Regional Park District): We are in the process of collecting data to determine if our swimming beaches comply with the draft guidelines for freshwater *beaches. One of the things in the guidelines is that you are supposed to collect your samples within 4-24 inches of water. Mr. Anderson, you indicated that you collect your samples in 4 feet of water?*

Mark Anderson:

Yes.

Comment (Ken Burger): We also used to collect samples in 4 feet of water and found significantly lower numbers than what we were getting in knee-deep water. I think the reason for that is this is where the young kids play. All it takes is one AFR (accidental fecal release) or one dirty diaper when you are taking your sample. We have done some sampling in the morning before the people arrived at the beaches and then in the afternoon during the peak times and we see huge differences. There is a lot of human input in shallow waters from human contact. Our concern is if you are using single samples to determine when to post, it looks like we are going to be posting all of our beaches. It is common to exceed 400 fecal coliforms per 100 mL during peak use, in shallow water, and on warm summer days. That is a concern to us. I don't know how this is going to be addressed and it may create a public reaction. We are looking for ways to deal with this that allow the beaches to stay open and meet the requirements at the same time. One of the things in the guidance created a dilemma for us. It doesn't make sense for us to post a beach, collect samples 5 days later with low numbers, take the signs back down, and then put them back up. It's a difficult situation to be in.

Mark Anderson:

We did a study last year where we took samples from 4 feet, 3 feet, and 2 feet of depth. We got an inverse relationship between the counts and the depth. The closer that you get to the shore, the higher the counts. We also did a study where we found that there were high numbers of fecal coliform bacteria being sequestered in the sediments.

Comment (Ken Burger): We are being requested by the two county health departments to use the draft freshwater guidelines. When we do that, we see that beaches that are we in compliance with the old requirements are all in jeopardy now. It's creating a totally different picture of an old situation. We've implemented a diaper ban recently and I'm still answering letters from irate housewives claiming that the park district is anti-American and anti-children. It's creating a lot of concern.

Q (James Alamillo, Heal the Bay): I run the beach report card for Heal the Bay and look at a lot of data from a variety of agencies who monitor their beaches under the AB411 regulation. Some of the agency data that I have come across use E. coli in lieu of fecal coliform as a dataset. How would one interpret E. coli, *in terms of the regulation, and determine the threshold by which to close/post the beach? Where is that threshold derived?*

Steven Book:

We understand that some of the counties are using Colilert® to monitor for fecal coliforms. The test measures *E. coli* and some are using a 1-to-1 correlation and some use a 1.1 or 1.2 correlation. We are hoping to come out with some guidance on that subject. In the interim, I think that we would expect the counties who are using *E. coli* to predict fecal coliforms to document the results of split samples run by two different methods to show the correlation. If it's 1-to-1 or 1.2-to-1, what's the justification? For your Heal the Bay report card, when you describe the methodology, you could include a sentence for each of the counties on how they make that correction so that people who want to compare counties or want to make a correction so that all data are comparable can do so.

Comment (Dan Mills, California Department of Health Services): I think there are some people in the room who have experience with that correlation. Charlie Mc Gee do you have any recent information since we last spoke about it? I think the SCCWRP (Southern California Coastal Water Research Project) laboratories have some comparative data between the methods.

Charles McGee:

We have looked at the relationship of *E. coli* to fecals using the Colilert® product and A1 medium as an example. When we look for wastewater around our outfall, it appears that about 90 percent of the fecals are *E. coli.* That's relatively fresh contamination and I would expect it to change a little bit as this contamination is dispersed toward the beach. I do not have good numbers to give to you. Who knows what it is in all wastewaters. We couldn't compare *E. coli* and fecals in the intercalibration study last year because in three of the five samples, we used *E. coli.* From two of them we did and we have a little bit of information. Rachel, do you remember, have we looked at that at all?

Comment (Rachel Noble, University of Southern California): We singled out Colilert® results, especially in Charlie's case when we did the Bight 1998 Microbiology Study. For quite a few of the samples the lab ran both, and we found that the Colilert® number represented 90 to 95 percent compared to the number gotten by the other method. A few percent lower, because we were sampling seawater and not wastewater.

Q (Mark Gold, Heal the Bay): Let's assume that you would use a multiplier, like 1.1, times your E. coli *to come up with a fecal threshold to decide whether or not to post. What would you do with the fecal-to-total ratio? Would you take that a step further and compound that uncertainty?*

Steven Book:

If you were making an estimate by taking your Colilert® number and multiplying it by 1.1 and using that as your fecal coliform value, then you would use that as your numerator in your fecal over total ratio.

Comment (Al Dufour, USEPA, Office of Research and Development): I think we shouldn't play these number games. As one of my slides earlier showed, the number of *E. coli* in sewage treatment plant samples can range from 92 percent of the total fecal coliforms down to 60 percent of the fecal coliform numbers. With that variation, I don't know how you can compare that to a method that measures only *E. coli.* You might come up with some average number, but on a sample by sample basis, I don't think that it will be very meaningful. I think you have to be careful when you try to say *E. coli* is X percentage and therefore we can multiply by 1.2 and then compounding that by making it a part of a ratio which is even less stable than the *E. coli* percentage of the fecal coliform. I would add a note of caution before doing things like that.

Steven Book:

I also have to agree that you have to use caution, but there is also redundancy because we are doing sampling for enterococcus at the same time and we are doing weekly samples. We will look at this more as the implementation of the program proceeds.

Q (Roger Fujioka, University of Hawaii): It's clear that the source of most of the beach pollution has been identified as storm drains, rivers, or lakes coming into the beach area. I have not seen enough data on the concentrations of the indicators in these kinds of waters. It would be a greater variation in these kinds of waters than in sewage. Do you have the data on the freshwater sites and their impact as it goes out into the ocean? How do you manage the runoff from the land?

Charles McGee:

This summer, in southern California, the major metropolitan sewage agencies that treat the wastewater are being pressured to accept the nuisance flow in the summertime. That is happening in LA County and Orange County. My agency is accepting the nuisance flows. Obviously, that can't happen during the rainy season, but we don't get rain in the summertime. These flows are being diverted right now just to remove the problem, not addressing the problem. It's just taking the contamination to the treatment plant.

Q (Roger Fujioka): How do you characterize the freshwater as to whether it's a lake, storm drain, or river? If it's a high level what do you do about it? Is there any way to control that contamination from the land, up in the watershed?

Charles McGee:

It depends on the level and the flow of the discharge. We need to know what happens to freshwater when it hits the ocean. The state and Heal the Bay are working on some distribution models of what happens to the freshwater when it hits the ocean. Those are in the design phase right now. It needs to be done, it is a very critical component in the equation that we don't have now.

NRDC's Testing the Waters, 1999

David Beckman
Natural Resources Defense Council

The Natural Resources Defense Council has published *Testing the Waters*, its annual summary of beach closure and advisory data in the United States, for nine years. NRDC compiles data from independent surveys and from data collected by the United States EPA. The *Testing the Waters* project was conceived by its project director, NRDC Senior Attorney Sarah Chasis.

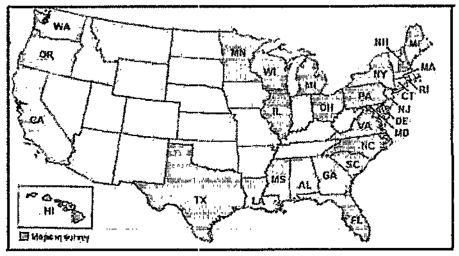
The 1999 edition of *Testing the Waters* documents 7,236 beach closures and advisories in the United States during calendar year 1998, a figure that is nearly twice as large as the figure for 1997, and nearly three times the number recorded in 1996.

On a state-by-state basis, California logged the most closures and advisories during 1998, with over 3200 closures and advisories. Florida posted nearly 1900 closures during 1998. It is important to note that states such as California that have monitoring programs in place may post higher numbers of closures and advisories than states that do not. Accordingly, the total number of closures recorded in a year in one state or locality may not necessarily convey relative information about beach water quality.

When the reasons given for beach closures and advisories during 1998 are examined, it is clear that water quality monitoring results provide the largest basis for the beach closures and advisories (69%); known pollution events (27%) and precautionary action (8%) are also significant reasons.

Looking at the issue from a slightly different perspective, the major sources of pollution listed as responsible for beach closures in 1998 were as follows: broken sewer lines and overflows (48%); polluted runoff (31%); and rain-related preemptive action (21%).

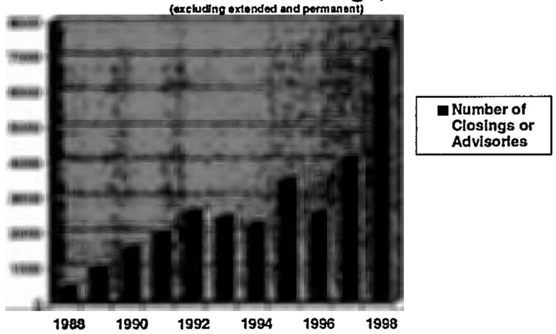
NRDC's *Testing the Waters* report is now accompanied by online information that allows Internet users to access information about particular beaches around the country. This information is part of NRDC's Internet site, www.nrdc.org.



STATES INCLUDED IN TESTING THE WATERS 1999

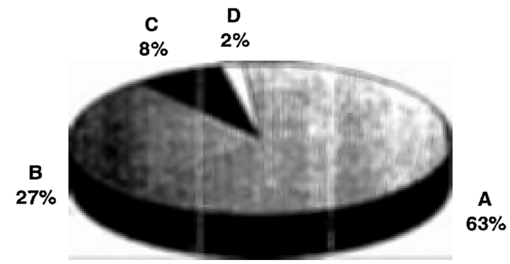
Total Advisories and Closings, 1988-1998

(excluding extended and permanent)



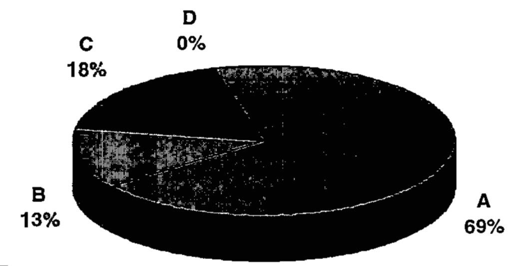
Note: Because of inconsistencies in monitoring and closing practices among states and over time, it is difficult to make comparisions between states or to assess trends over time based on the closing data.

Reported Causes of Advisories and Closings in 1998



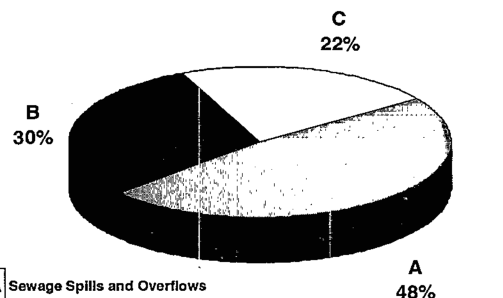
- A based on monitoring that detected bacteria levels exceeding standard
- B response to known pollution event without relying on monitoring
- C precautionary due to rain known to carry pollution to swimming waters
- D other reason

Reported Causes of Advisories and Closings in 1997



- A based on monitoring that detected bacteria levels exceeding standard
- B response to known pollution event without relying on monitoring
- C precautionary due to rain known to carry pollution to swimming waters
- D other reason

Pollution Sources Responsible for Closings in 1998



- A Sewage Spills and Overflows
- B Polluted Runoff and Stormwater
- C Rain or Preemptive (usually due to polluted stormwater or sewage overflows)

Beaches Indicating Stormwater As Pollution Source

STATE	Total Number of Beaches Reported in 1998	Number of Beaches Indicating Stormwater Pollution Source	Percent Indicating Stormwater Pollution Source
New Jersey	222	175	79%
California	144	116	81%
Florida	216	90	42%
Connecticut	100	81	81%
Michigan	157	65	41%
New York	131	47	36%
Massachusetts	75	31	41%
Ohio	60	29	48%
North Carolina	20	20	100%
Indiana	37	18	49%
Wisconsin	45	18	40%
Illinois	34	13	38%

FOUR STATES LACK ANY REGULAR MONITORING OF BEACHWATER FOR SWIMMER SAFETY

- ALABAMA
- LOUISIANA
- OREGON
- WASHINGTON

THIRTEEN STATES HAVE REGULAR MONITORING AND PUBLIC NOTIFICATION PROGRAMS FOR A PORTION OF THEIR RECREATIONAL BEACHES

- CALIFORNIA
- FLORIDA
- HAWAII
- MAINE
- MARYLAND
- MASSACHUSETTS
- MICHIGAN
- MINNESOTA
- RHODE ISLAND
- SOUTH CAROLINA
- VIRGINIA
- WISCONSIN
- NEW YORK

ONLY NINE STATES COMPREHENSIVELY MONITOR MOST OR ALL OF THEIR BEACHES AND NOTIFY THE PUBLIC

- CONNECTICUT
- NORTH CAROLINA
- DELAWARE
- OHIO
- ILLINOIS
- PENNSYLVANIA
- INDIANA
- NEW HAMPSHIRE
- NEW JERSEY

1988 COSTS OF OCEAN, BAY AND GREAT LAKES BEACH-MONITORING AND/OR ADVISORY-CLOSING PROGRAMS

STATE	COST	NUMBER OF COUNTIES REPORTING	MILES MONITORED	COST PER BEACH MILE
California	$1,237,929	43	292	$4,239
Connecticut	$191,955	52	41	$4,682
Delaware	$31,250	3	7	$4,464
Florida	$222,470	83	163	$1,365
Georgia	$170,000	1	NP	
Illinois	$59,750	15	13	$4,596
Indiana	$32,500	16	10	$3,250
Maine	$9,250	12	10	$925
Maryland	$226,300	24	29	$7,803
Massachusetts	$72,750	56	54	$1,347
Michigan	$137,750	77	39	$3,532
Minnesota	$7,500	3	1	$7,500
Mississippi	$175,000	3	40	$4,375
New Hampshire	$5,250	3	NP	
New Jersey	$250,000	3	17	$14,706
New York	$532,200	49	28	$19,007
North Carolina	$361,250	6	270	$1,338
Ohio	$78,350	18	7	$11,193
South Carolina	$132,500	15	25	$5,300
Texas	$114,274	13	10	$11,427
Virginia	$84,000	15	54	$1,556
Wisconsin	$103,750	63	8	$12,969

NP = Not Provided

COMPARISON OF MONITORING AND CLOSURE POLICIES OF BEACHES IN DELAWARE, MARYLAND AND VIRGINIA

BEACH	INDICATOR ORGANISM	TESTING FREQUENCY	CLSOING/ ADVISORY ISSUANCE
EPA-recommended criteria	enterococcus	generally not fewer than 5 samples equally spaced over a 30-day period	greater than G.M.* of 35/100ml or a single sample of 104/100ml for a designated bathing beach
Assateague Island National Seashore, VA	enterococcus	weekly	greater then G.M.* of 35/100ml** or a single sample of either 104/100ml for guarded beaches or 158/100ml for non-guarded beaches
Bethany Beach, DE	enterococcus	weekly (summer months)	greater than G.M.* of 155/100ml** or a single sample of 2,212/100ml
Virginia Beach, VA	fecal coliform	biweekly	greater than G.M.* of 200/100ml** or a single sample of 1,000/100ml
Ocean City, MD	fecal coliform	monthly	greater than G.M.* of 200/100ml** or 400/100ml of 10% of the samples (discretionary closures)

* G.M. means geometric mean
** Five samples taken over a 30-day period

VALUE OF COASTAL TOURISM TO SELECTED STATES

STATE	YEAR	DOLLAR VALUE (Billions)	NUMBER OF RELATED JOBS
Alabama	1998	1.7	39,309
California	1997	37.6	367,530
Georgia	1998	2.14	Not available
Hawaii	1998	14.6	179,950
Massachusetts	1996	6.5	70,000
New Jersey	1998	5.8	267,000
North Carolina	1997	1.4	25,850
Oregon	1997	1.3	19,703
South Carolina	1997	4.0	73,284
Texas	1997	1.9	30,500

Session Four: Beach Advisories, Closures, and Risk Communication

Communicating About Risk

Sharon Dunwoody
University of Wisconsin-Madison, School of Journalism and Mass Communication

Communicating well about a risk, any risk, requires three domains of expertise: (1) topic expertise, (2) audience expertise, and (3) storytelling expertise. Many risk managers emphasize the first over the other two. But leaving even one of the three to chance can be lethal to a risk communication effort. In this talk, we'll look briefly at those two neglected domains.

Audience Expertise

The landscape of risk information campaigns is littered with efforts that have foundered on this issue. Knowing enough about the audience to make educated guesses about the nature and structure of risk messages is difficult, as each risk situation has its unique characteristics. However, there are some general patterns emerging from a growing risk communication and health campaign literature that will come in handy:

- Audiences often bring well-developed beliefs about a risk to your issue. If your message offers content that collides with those beliefs, the thing most likely to get modified is your message, not the beliefs.
- The ability of audience to reconstruct messages to fit their own beliefs means that the strongest effect of the typical risk message is to reinforce existing beliefs, not change them.
- Individuals will distinguish between their personal level of risk and the risk posed to others, and they will employ different channels of information to inform those different types of risk judgment.
- The typical members of your audience will give your risk message a modicum of their time. This means they will analyze that message speedily and superficially. Additionally, they will bring to that message a set of cognitive processing strategies that may truncate their ability to understand the evidence that you present.
- Audiences will develop their own notions of source credibility, and those notions may differ from yours.

Storytelling Expertise

Knowing some of these things about your audience can help you construct "stories" about risk that stand a chance of being ingested and understood. Here are some story attributes that are sensitive to the issues mentioned above:

- If you sense that members of the audience indeed bring strong beliefs to the table, then you can try to cope with those beliefs in your message. This is not easy, but a storytelling strategy that is sensitive to strong beliefs may actually succeed, while one that is insensitive is guaranteed to fail. Here is how one might organize a message with strong beliefs in mind:
  1. Acknowledge the usefulness of the prevailing belief.
  2. Then, demonstrate how the prevailing belief fails to explain reality in other situations.
  3. Offer up the propositions you hope will replace the prevailing belief.
  4. Demonstrate how those propositions successfully explain a variety of situations similar to the risk situation you face.
- Individuals will distinguish between their own personal risk and risk to others. They will want to interpret the typical risk message (i.e., mass messages) as telling

them something about *others'* risk and will resist seeing those messages as informing their understanding of their *personal* risk level. To influence personal risk judgments, interpersonal channels are best.
- Anticipating the kinds of cognitive biases that you will face allows you to embed in your message explanations to help counteract them.
- Heuristic (superficial) processing of messages means that audience members will be relying on message cues to decide what they think about a risk. Channel credibility and source credibility will be important cues. But other cues can be built into the messages themselves.
- In a world of heuristic processors, keep messages short.

Communicating About Risk

Sharon Dunwoody
School of Journalism and Mass Communication
University of Wisconsin-Madison

Three types of expertise

- Topic
- Audience
- Storytelling

Audience expertise

- Audiences already have robust beliefs
- The strongest effect of a message is **reinforcement** of those beliefs
- Risk referent matters
- Speedy interpretation will be the norm
- Credibility judgments are audience--not source--judgments

Storytelling expertise

- Coping with strong beliefs
  - Acknowledge usefulness of prevailing beliefs
  - Demonstrate flaws of those beliefs
  - Propose a new set of beliefs
  - Demonstrate utility of the new beliefs

Storytelling expertise

- My risk vs. their risk

  Use mediated channels to encourage people to learn about a risk but interpersonal channels to promote behavior change

Storytelling expertise

- Anticipate cognitive biases that people will bring to your message
  - The power of anecdotal evidence
  - All things have causes
  - Oversimplification of cause and effect

Storytelling expertise

- Heuristic information processors will rely on different message cues than will systematic information processors
  - •Brevity is best
  - •Credibility of channel matters more than credibility of source
  - •What single main point do you wish to convey?
  - •Expertise cues are important

The Aftermath of the Santa Monica Bay Epidemiology Study

Mark Gold
Heal the Bay

In the spring of 1996, the Santa Monica Bay Restoration Project (SMBRP) released the results of the first ever epidemiology study on swimmers in urban runoff contaminated waters. The USC-led study demonstrated that there was a significant correlation between the incidence of adverse health effects and exposure to runoff contaminated waters with high indicator bacteria densities. Subsequent to the release of the study, there has been a great deal of progress on beach public health issues.

In the Los Angeles area, a new beach closure and health warning protocol was developed and the county lifeguards now warn people to avoid swimming in runoff-contaminated waters. Also, local government agencies have initiated a program to divert the dry weather runoff from polluted storm drains and into the sewer system. Dry weather runoff diversions take polluted runoff out of the surfzone, thereby greatly reducing the health risks to swimmers. By the end of the summer, seven runoff diversions will have been implemented with another five scheduled for next year. Also, San Diego has implemented a similar runoff diversion program on an even larger scale. Perhaps the most unique project is the Santa Monica Dry Weather Runoff Diversion Facility scheduled for completion in the spring of 2000. This project will treat up to 500,000 gallons per day of runoff with filtration and disinfection. The treated runoff will be used for irrigation within the community.

Shortly after the release of the study, Santa Barbara County initiated a shoreline indicator bacteria monitoring program and a beach closure and health warning protocol.

Statewide, the major outcome of the study was the passage of Assembly Bill 411 authored by San Diego's Howard Wayne. Last month, the California Department of Health Services issued emergency regulations to implement bill requirements. For the first time, California has statewide bathing standards (based largely on the results of the SMBRP epidemiology study), mandatory requirements to post polluted beaches with warning signs and close beaches polluted by sewage spills, and mandatory monitoring programs for popular, runoff contaminated beaches. Also, the state will provide funding to local health agencies to implement AB411 requirements. For the first time, water quality data and beach closure information will be comparable from county to county.

On a regional basis, Heal the Bay has expanded its weekly Beach Report Card to include over 250 locations in Orange, Los Angeles, Ventura and Santa Barbara counties. For the last nine years, Heal the Bay has graded over 60 beaches in Los Angeles County on a scale of "A" to "F" based on bacterial indicator densities in shoreline waters. The grades are based on the frequency of days over a 28-day period that exceeds AB411 thresholds. Heal the Bay uses the monitoring data from health agencies and sewage treatment plant monitoring programs. All of the agencies in Southern California have been extremely cooperative in sharing data on a timely basis so that Heal the Bay can release the information to the media and put it on our web site (www.healthebay.org) by noon every Friday. The Report Card has proven to be a very popular tool to provide the public with water quality and beach closure information. Heal the Bay hopes to add San

Diego beaches to our Beach Report card by the end of the year.

EPA Region 9 has contracted with Heal the Bay to complete a model national beach standards, monitoring and public notification program. Currently, staff are still in the information gathering and drafting phase. Our hope is to release a peer-reviewed document by the end of the year. The objective is to provide a national model program that will provide comparable data from region to region and that will provide the public with water quality information in a timely manner.

An upcoming study led by the Southern California Coastal Waters Research Project with the city of Los Angeles and Heal the Bay should provide valuable information on the importance of storm drain flow and shoreline currents on the fate and transport of indicator bacteria. One of the shortcomings of the SMBRP epidemiology study was the lack of flow and current data. The end result was that there was no significant correlation between the incidence of adverse health effects and the distance swimmers were from flowing storm drains. Risk managers need to be able to provide the public with general recommendations to reduce the risk of adverse health effects on swimmers. One of the goals of the study is to provide recommendations on a simple model to apply nationwide for risk managers to protect the health of swimmers at contaminated beaches. The study should be completed by next spring.

Another ongoing effort is the development of bacterial indicator and pathogen Total Maximum Daily Loads (TMDLs) for all Ventura and Los Angeles County beaches by 2003. The Los Angeles Regional Water Quality Control Board (LARWQCB) is currently in charge of this effort. This program is a result of a Heal the Bay, Santa Monica BayKeeper lawsuit brought by the Natural Resources Defense Council against EPA. The end result should be TMDL development for all beaches impaired for recreational water contact, the development of Waste Load Allocations and Load Allocations for fecal bacteria sources upstream of the polluted beaches, and an implementation plan for achieving the TMDLs and the load allocations.

In a related effort, the LARWQCB is working with Malibu on a study of septic systems and their potential role in contributing high densities of indicator bacteria at local beaches. Also, Assemblywoman Hanna-Beth Jackson has introduced AB885 to develop performance standards for on-site wastewater treatment facilities in coastal counties. The bill became a two-year bill after objections from Malibu, some coastal counties and realtor associations. Currently, there are no state regulations governing water quality from on-site treatment systems.

The Aftermath of the Santa Monica Bay Epidemiology Study

Dr. Mark Gold
Executive Director
Heal the Bay

Santa Monica Bay Epi. Study

- First epidemiological study on swimmers in urban-runoff contaminated waters
- Designed to answer two questions:
  - Is distance of swimming from storm drain associated with risk of adverse health outcomes?
  - Do bacteria indicators predict risk of adverse health outcomes?

Major Finding of Epi. Study

- Correlation between incidence of adverse health effects (gastroenteritis and upper reparatory infections) and swimming in water with high indicator densities
- Those who swim in front of flowing drain are twice as likely to get sick than those 400 yards away

Changes in S. California

- Santa Barbara initiated a monitoring and notification program
- San Diego developed a dry weather diversion plan
- LA County
  - Signs posted at every flowing storm drain
  - Lifeguards actively warn swimmers near drains
  - Local government agencies commit to dry weather diversions

SM Bay Dry Weather Diversions

- Total of 12 diversions
  - 2 completed since epi. study
  - 5 in 1999, 4 in 2000, 1 in 2001-2001
- City of LA, County of LA, City of Santa Monica
- Santa Monica Dry Weather Runoff Diversion Facility (DWRRF) - 2000

Statewide Changes—AB411

- Major outcome of Epi. Study
- Passed without major opposition
- Consistent monitoring, posting and closure protocols throughout the state
- Significant Public Right-to-Know component
- Improved programs in several counties such as Ventura County, Long Beach

Expansion of Heal the Bay's Beach Report Card

- 250 beach locations
- Expansion includes Orange, Ventura and Santa Barbara Counties, and Long Beach
- Modification of grading system
- Annual Beach Report Card expansion

On-Going Efforts in SM Bay

- SCCRWP Beach Closure Study
  - Physical and/or statistical model of bacteria indicator plume from storm drains in SM Bay
  - Predictive tool for length of beach impacted
- Malibu septic tank investigation
  - Chronic contamination at Surfrider Beach
  - RWQCB/City of Malibu source investigation

On-Going Efforts—State Legislation

- AB 885 (Jackson)
  - Requires state standards for on-site wastewater treatment systems
  - Much opposition, now a 2-year bill
- AB 538 (Wayne)
  - Follow-up to AB 411
  - Requires DHS to establish source investigation protocol

On-Going Efforts Regional

- Beach Water Quality Group\
- EPA's Model Program for Beach Monitoring and Public Notification
- EPA's West Coast Beach Health Website

LA and Ventura County Microbiological TMDLs

- Consent Decree established schedule for development
- $340k to support development of SM Bay Coliform TMDL
- Heal the Bay supports:
  - TMDLs equivalent to AB 411 standards
  - Implementation through Basin Plans, permits and watershed management plans

Future Actions

- Promote National Bathing Water Standards
- Promote Beach Report Card or similar format to inform the public
- Ensure AB-411 is working as intended
- Support development of source investigation protocol
- Support development and implementation of microbiological TMDLs

Beach Advisories and Closures

Chris Gonaver
County of San Diego Department of Environmental Health

The Beach Safety Bill (AB411, Wayne, D-San Diego) was signed in to law in 1997 to provide for statewide standardization of coastal water testing, beach posting criteria and increased public health protection for recreational users of our coastal waters. This law requires coastal municipalities to test beach water quality within their jurisdiction and to post warning signs whenever water quality fails to meet bacteriological standards adopted by regulation. The California Department of Health Services (DHS) developed emergency regulations for AB411 that standardize the testing of coastal waters, posting criteria and the dissemination of beach closure information to the public.

The regulations (17 CCR §115880 *et seq.*) require local health officers to:

- Weekly test coastal water at all public beaches between April 1 and October 31; where (a) storm drains flow to the surf zone and (b) have 50,000 visitors annually,
- Analyze samples for four indicator criteria: total coliform (TC), fecal coliform (FC), TC/FC ratio and enterococcus,
- Post beaches with signs when regulatory health standards are exceeded,
- Notify the public via telephone hotline [(619) 338-2073] when beach water quality exceeds regulatory health standards.

The Department of Environmental Health (DEH) is the local agency responsible for implementing AB411 in San Diego County. Many features incorporated in AB411 are modeled from DEH's existing Beach & Bay Monitoring Program. Under the new AB411 program, samples are collected weekly from 138 coastal sites. When state standards are exceeded, beaches are posted with warning signs and the public is notified via a beach closure hotline, via the DEH Web site (www.co.san-diego.ca.us/deh) and on the weather page of the local newspaper (*San Diego Union-Tribune*).

AB411 uses the terms "posting" and "closure." "Posting" is used at beaches where recreational water contact is restricted due to storm water runoff pollution and "closure" is used at beaches where recreational water is restricted due to sewage spills. Past regulations and practice caused a beach to be posted if total *and* fecal coliform water quality standards were exceeded. AB411 regulations will require a beach to be posted (closed) if any one of four water quality standards is exceeded. The scientific evidence that supports this state requirement has been questioned by many local agencies. A study published in April 1999 by the Southern California Coastal Water Research Project, found a high degree of inconsistency among the three bacterial indicators used as the basis for beach posting decisions.

The bottom line is that the new AB411 regulations will probably result in an increase in beach postings (closures) and a corresponding perception by the public that water quality at our beaches has decreased. In reality, we are just using a different set of indicators.

On the plus side, the Beach Safety Bill (AB411) requires standardized coastal water quality monitoring and public notification for all coastal municipalities. Unfortunately, much of the scientific evidence is unavailable to demonstrate that the proposed bacteriological recreational water quality standards will achieve the intent of AB411: to reduce risk of illness due to contact with contaminated coastal water.

EPA

1999 Beach Conference

Beach Closures & Advisories

Chris Gonaver, Chief

County of San Diego

Department of Environmental Health

Land & Water Quality Division

Beach Closures and Advisories

- protect bathers from illness
- warn bathers of risk
- inform bathers about pollutant sources

Legal Framework for Beach Closures

- Federal
  - Pending Legislation
    - HR 999 (Bilbray)
- California
  - Existing Law
    - H&SC §5410 *et seq.*
    - H&SC §115880 (AB411, Wayne)
  - Emergency Regulations
    - 17 CCR §7956 *et seq.*

Following California Regulations

- Single Sample Standard
- 5 Week Log Mean Standard

Definitions

- CLOSURE
  - sewage spills
  - persistent problems
- POSTING
  - pollution at storm drains
  - exceedance of standards
- GENERAL ADVISORY
  - urban runoff following rain (>0.2")

Map of San Diego's Sample Sites

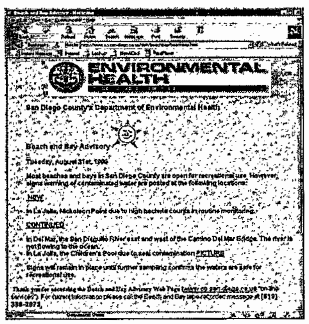
- 138 Coastal Sites
  - 55 by City of SD
  - 54 by County
  - 5 by Encina
  - 6 by IBWC
  - 11 by Oceanside
  - 7 by San Elijo

Beach Closures and Advisories

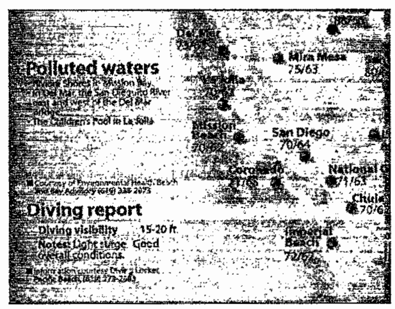
- Beach Postings & Closures result in:
  - signs placed in the sand
  - web site that lists locations
  - newspaper that lists posted beaches
  - press release (if closed due to sewage)
  - recorded message on telephone hotline
- Advisories
  - web site notification
  - newspaper notification
  - recorded message on telephone hotline

Informative Signs

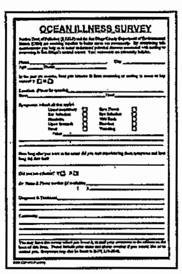
Webpage Notification



Newspaper Notification



Ocean Illness Survey



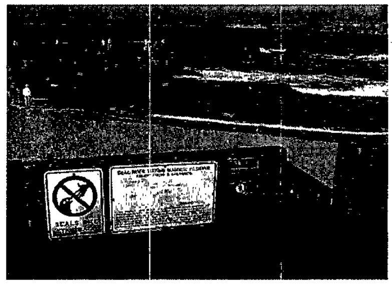
Overall Status

- Postings / Closures
  - Before AB411 Regulation (<7/26/1999):
    - about 1 posting/week
    - about 1 closure/week
  - After AB411 Regulation (>7/26/1999):
    - about 3 postings/week
    - about 1 closure/week

Determinants of Beach Postings/Closures Since AB411

- Postings Attributed to AB411 are due to:
  - Single standard exceedance (Enterococcus),
  - Single day exceedance (confirmation sample would not detect presence of bacteria exceeding standards)
- Closures Attributed to AB411 are:
  - not yet determined (5-week Log mean)

Posting at Childrens Pool



Getting more Information

- Internet:
  - www.co.san-diego.ca.us/deh
- Beach and Bay Hotline:
  - 619-338-2073

Question-and-Answer Session

Panel: David Beckman, Sharon Dunwoody, Mark Gold, and Chris Gonaver

Q (Suzanne Michel, San Diego State University, Department of Political Science): One of the things that I have noticed, especially here in San Diego, is issues of beach closures, water issues, and urban growth. There is a serious disjunct between what is happening in coastal communities and inland communities. Inland communities upstream are rapidly growing. They don't care about storm water. If there are sewage spills, there is no notification. It's good that we are talking about what is happening at the beaches, but we need to start thinking about what's going on upstream. Upstream is where the urban growth is occurring, and the upstream communities don't care what's happening downstream. With Heal the Bay are you starting to interact with these groups and look at the watershed perspective?

Mark Gold:
We are very involved in watershed management and have been for over a decade at Heal the Bay. I think that one of the biggest reasons that the BayKeeper, NRDC, and Heal the Bay brought the TMDL lawsuit in the Los Angeles region was this very issue. We were increasingly frustrated by the lack of uniformity in compliance with weak storm water permits. We have each fought many storm water permits, trying to get them tougher and tougher. The reality is that until you get wasteload allocations and load allocations assigned to certain cities as part of their storm water permits, the issue that you are concerned about, I think, is going to continue to happen. As long as watershed management is 100 percent voluntary, these problems are still going to occur. We got involved in all of the various activities, watershed management committees, TMDLs, and storm water permit commenting.

Chris Gonaver:
Sewage spills are treated equally no matter where they are in the county. Public notification and posting–all are treated the same way. The ones in the coastal areas are just most obvious with more signs. Regarding watersheds, there is a large effort under way in the county to coordinate watershed involvement. I think that those watershed activities have been in the closet individually for a long time, but there is a real effort now to bring everybody together and share information as far as who is doing what. From the land use standpoint, there are storm water requirements in place for development and redevelopment construction. Talk to Donna Frye for watershed planning information.

Comment (Suzanne Michel): I just want to comment to make my point. I know sewage spills are all treated the same. There was a huge spill in Santee, 400,000 gallons. I went around and talked to people in Santee and (a) not one person knew about it and (b) they didn't even seemed to care, that's just what happens. When you're sitting at the beach with a closing, you care. There is a definite disjunct in attitudes between coastal and inland communities. I think we need to do more to get the inland communities more involved in understanding what is going on downstream.

Q (Douglas Moore, Orange County Public Health Laboratory): On the posting versus closings, San Diego isn't the only area confused by the signs. Since a posting equals a closing, are the lifeguards ticketing on postings and closings?

Chris Gonaver:
Yes. In the city of San Diego only. From our standpoint, we don't want people in the water for either of those events.

Mark Gold:
As a follow-up, in the LA region, we looked at it as a voluntary versus an involuntary risk. That's why we differentiate between postings versus closings. You can't close Surfrider Beach permanently. As Chris was demonstrating with the health survey, if it's breaking at 2 to 4 feet at whatever beach, people are going to be there. To put that sort of impetus on the lifeguards and the public. I think that the Surfriders want to use their own discretion.

Comment (Douglas Moore): In the city of Huntington Beach the Mayor said that I would be fined $500 for going in the water when there was a posting or a closure. I don't see how to explain to the public the difference between a posting and a closing.

Comment (Chris Kinner, Surfrider Foundation): They advocate personal risk management with regard to the postings and closures. They also advocate an informed public and want them to know the potential for contamination and the associated risks. Many surfers are water conscious and water aware and are able to make those certain risk assessments on their own. Obviously with known closures due to contamination many surfers aren't going to weigh a personal choice. If its closed, its closed.

Q (Sydney Harvey, Los Angeles County Department of Health Services): I find the data from Mark Gold's report on the Santa Monica Study relevant to the total-to-fecal coliform ratio correlation to human disease very intriguing. I wonder if you did species identification of the total coliforms?

Mark Gold:
No, it was just the standard test. Both membrane filtration and multiple tube methods were used.

Q (Sydney Harvey): Did you select colonies for species identification?

Mark Gold:
No.

Q (Sydney Harvey): You did not know if you were looking at coliforms or a high percentage of aeromonads?

Mark Gold:
That is correct.

Q (Sydney Harvey): Are there any plans to do this?

Mark Gold:

No. It sounds like these are things we should really talk about.

Q (Sydney Harvey): Did the Los Angeles County Public Health Laboratory do some of the assays relevant to your study?

Mark Gold:

The county monitors about 35 beaches every week. During the course of the actual epidemiological study, all the bacteriological surveys were done by the City of Los Angeles Environmental Monitoring Division by membrane filtration. Los Angeles County only participated as reviewers.

Comment (Sydney Harvey): We have looked at total coliform populations coming from various places along the Los Angeles County coast. Quite a number of what are obviously false positives are aeromonads. They are not coliforms and, depending on the test methodology one uses, you can get Vibrio as false positives. I think that it would be very interesting and informative to look at what the total coliform and fecal coliform really means in terms of health risk.

Q (Clay Clifton, San Diego County Department of Environmental Health): Is there a policy or guidance from EPA or another agency regarding posting of contaminated water signs at a beach which is already under a general advisory for rainfall? If you have a significant rainfall event on a Sunday night, that rainfall advisory will be in effect at all beach locations adjacent to flowing storm drains and river outlets for 72 hours from Monday on. If Monday's samples are high, is there guidance that says that the location should be posted with a sign? If you have routine data with high bacteria counts for a location that is already under a general advisory, what's the proper notification? Are you serving the public to post a beach that is already under a general advisory and not post an adjacent beach which does not have a routine sample location, but has a flowing storm drain? Are you sending a mixed message?

Sharon Dunwoody:

The only thing that you can do in that situation is ask people. One of the things that I do is spot interviewing on a site. Ask the people how they are interpreting the signs that they see. We don't know how the people are reacting to the signs in your area, but there are ways of finding out.

Q (Clay Clifton): From risk assessment, is it better to have the population at beach A notified with signs because you have the routine sample that confirms high bacteria levels after a rainfall event or beach B which does not post because they do not have the data to verify the high bacteria counts? Are you better off to save one and not post signs at the beach for the second?

Comment (Rick Hoffman, US Environmental Protection Agency, Office of Science and Technology): EPA's official guidance is currently confined to general, ambient monitoring of water quality, not for beach advisories, so that falls to the county health department. That is one of the things that we are going to be talking about in our future guidance.

Mark Gold:

Most of the counties that I have dealt with feel that as long as they change their hotline and get the information out to the media about the rainfall by sending out a press release every time it rains, that should suffice. I think that putting signs up is redundant. We need to get the message out that when it rains, you shouldn't go in.

Comment (Gerry Winant, Santa Barbara County Environmental Health Services): Three years ago, we didn't have a program. We got blasted by the national press for not having a monitoring program. Finally, the Board of Supervisors took the heat from the public and decided that this was something that we needed to do. That was the formative step to do that and thanks to Heal the Bay for helping develop our program. Also, I would like to comment that I found that the transition of the NRDC survey to the EPA format is unworkable. It seems overdetailed, and I'm not sure how much information can adequately be conveyed in that format. Some of the information is difficult to accumulate.

Comment (Rick Hoffman): The purpose of the survey is to develop a national perspective and answer many different questions such as what standards are in effect, identify the beaches, and determine how many people visit those beaches (to give people a sense of utilization), etc. When we were formulating some of those questions, we looked at NRDC's survey and a couple of the state and local agency surveys. I think we recognize exactly what you have said, in that it is a very detailed questionnaire. We have tried to assist folks as best we can in putting it into a usable format. If there are ways that we can simplify the survey, we certainly are amenable to that and would appreciate any comments on those things you may feel are not as pertinent as others. Some of the questions are more "programmatic" (in the sense of the levels of monitoring, visitation, etc.). You might not need these facts, but on a nationwide basis, this provides important information such as the average costs and other general program characteristics. We hope that once you get the basic information into the database, the only changes should be the beach-specific information from year to year. It should be easier to complete the second year. The burden falls most heavily on some of the localities that have a small number of personnel and a fair number of beaches.

Q (Jim Colston, Orange County Sanitation District): One of the themes that I have seen in this session is the issue of urban runoff. Before the State Water Board is the Nonpoint Source Program. The official comment period closed on Monday, but there will be a public hearing. This is done in conjunction with the Coastal Commission and under CZARA. It's important to realize that the proposal is a three-tiered approach where there is a 15-year cycle: 5 years of voluntary, 5 years of encouraged, and then 5 years of an enforcement level for nonpoint sources. This is a rehash of a 1988 proposal. The comments we submitted are that they should redo the three tiers so that tier one would be for waters that meet standards, tier two would be for impaired waters that are low or medium priority for receiving a TMDL, and tier three for impaired waters that are a high priority for receiving a TMDL. We feel that this is a much more appropriate approach that will result in water quality improvement, assuming that the lists are done correctly. This will go before the Water Board soon. I hope that EPA would support the strengthening of California's regulations.

Mark Gold:

Thank you for bringing that up. That has been one of NRDC's and our organization's priorities over the summer. You are correct. I feel that the document will not bring us any closer to real watershed management; protecting our beaches; or stopping runoff problems caused by agriculture, marinas, or cities. It's just a list of what is going on in the state of California and there is no mention of how you move from one tier to another. There's no lead agency named. Unfortunately EPA and NOAA, the lead agencies federally, don't have any teeth in getting the state of California to strengthen the program, other than provide critical review. They can approve it or disapprove it, but that would get rid of the funding for the Coastal Commission, so there is little EPA and NOAA can do to help.

Summary of Breakout Groups

Breakout sessions were held at each of the regional conferences to gather input for the Beach Guidance document. Participants were asked a series of questions regarding the major topic areas that will be included in the document.

Major Topic Areas for Beach Guidance

1. Microbial Indicators of Water Quality
   a. Overview of health risks—previous studies
   b. Review of specific indicators
   c. Recommendations
2. Water Quality Monitoring
   a. Basic considerations in water quality monitoring
   b. Field procedures
   c. Laboratory procedures
3. Predictive Tools
   a. Rainfall-based guidelines
   b. Fate and transport models
4. Risk Assessment, Management and Communication
   a. Risk assessment
   b. Risk management
   c. Risk communication

Each breakout group was asked two questions for each of the four topic areas:

1. **Are there any additional major topics that should be considered for inclusion in the guidance?** (no additional major topic areas were identified)
2. **Identify the major challenges to successful implementation, possible solutions, and barriers to implementing the solutions.**

Microbial Indicators

1. Challenge: Ability to Conduct a Rapid Analysis
   Solutions:
   - develop a "dip stick" method
   - update new methods

   Barriers:
   - fluorospectrometry - needs validation and approval
   - consultants and vendors
   - cost
   - skills and training

2. Challenge: Use of Viruses in Addition to Currently Acceptable Indicators
   Solutions:
   - conduct further research on diseases caused by viruses
     - upper respiratory, skin, and ear infections
     - use of phages as indicators

   Barrier:
   - cost
3. Challenge: Need to Have Flexibility in the Choice of Methods and Indicators
   Solutions:
   - create a matrix to show comparability of validated methods for freshwater and marine water
   - change regulation(s) based on good science and associated health risks
   - update approved methods
   - include recommendations for assessing acute GI disease
   - recommendations should be based on different classes of risks (World Health Organization document, figure 5, page 20)
   - collect more data on human vs. animal indicators and health-associated risks
   - EPA should hasten the approval process for assessing indicators
   - determine which indicators are affected by tropical conditions
   - consider region and source applicability

   Barriers:
   - inconsistencies between programs
   - entrenched attitudes
   - established local laws
   - lack of communication
   - public confusion
   - cost
4. Challenge: Lack of a Central One-Stop Information Source
   Solutions:
   - publish EPA critique of new research on indicators
   - create a web site with relevant documents, information, case studies, and references

   Barrier:
   - internal (EPA) and external barriers to completing the research review

5. Challenge: Limitations of Existing Indicators and Methods (regional and source issues)
   Solutions:
   - develop a 3-track approach
     - improve existing indicators
     - develop better indicators
     - conduct health studies to verify existing and new indicators
   - improve communication between laboratories and regulatory agencies

   Barriers:
   - resources
   - technology
   - cost-effectiveness
   - West Coast data sets are different from East Coast

Water Quality Monitoring

1. Challenge: Improve Monitoring Coordination
   Solutions:
   - encourage storm water agencies to monitor bacteria
   - determine uses of data
   - investigate the use of volunteer monitoring programs
   - change legislation
   - coordinate regulations
   - use the TMDL process as a tool
   - develop sample handling procedures
     - need for longer storage
     - certify more laboratories

   Barrier:
   - variability of data vs. "load" target
2. Challenge: Sampling Design Issues
   Solutions:
   - consider the larger picture, history of the site, and pollution sources
   - consider and report local land use
   - define frequency and timing of sampling
     - change requirements for frequency of monitoring depending on type of incident
     - define when to resample
     - allow enough time in the standards to collect the samples
   - clarify the sampling schedule (peak and random)
   - consider sample parameters
     - wind speed, temperature, DO, pH, turbidity
     - collection location
   - suggest the "control chart" (quality control) approach
   - standardize aspects of the monitoring such as, depth, number of sites, and location and statistical protocols
   - develop nationally acceptable design considerations
     - include ambient vs. worse case
     - use technical workgroups for peer review
   - reevaluate monitoring regulations
   - correlate monitoring with health effects/risks

   Barriers:
   - currently not being done
   - compliance issues
   - sample representation of the swimming area
   - cost
   - time requirements to interpret and analyze the data
3. Challenge: Varying Sample Locations
   Solutions:
   - clarify areas to be sampled relevant to storm drains
   - address site-specific sampling, e.g.,storm drains

   Barrier:
   - difficult to distinguish for confined areas, e.g., open ocean and freshwater
4. Challenge: Need to Optimize Programs
   Solutions:
   - provide a tool box for identifying problems

- identify a lead agency to develop a model monitoring program
- develop ancillary data collection programs (beyond bacteria)

Barriers:
- cost
- leadership
- jurisdictional restrictions

Predictive Tools

1. Challenge: Application of East Coast, West Coast, and International Models
   Solutions:
   - consider appropriate locations, timing, and dry weather flows
   - develop two kinds of weather models based on wet and dry conditions
   - allow for adequate peer review

   Barriers:
   - data requirements and compilation
   - randomness of rainfall and pollution events
2. Challenge: Develop Rainfall-Based Guidelines
   Solutions:
   - consider regional variability
   - develop a general advisory (i.e., 2 inches for beaches and 0.1 inch for storm water)
   - develop guidance on how to adapt standards based on site-specific conditions

   Barriers:
   - regional variability
   - legal issues
3. Challenge: How to Assess a Rainfall Event
   Solutions:
   - coordinate with local storm water programs
   - develop a wet weather model

   Barriers:
   - frequent rain events
   - areas with high rainfall
4. Challenge: Lack of Comprehensive Predictive Tools
   Solutions:
   - offer grants to regional agencies to coordinate and manage fate and transport and flow-based dispersion models for personal computers
   - create a database of results to fit models
   - field test the models and determine risk management guidelines for a variety of requirements, e.g., waterbody type, lakes, and ocean
   - utilize local universities for research

   Barriers:
   - cost
   - reliability
   - technical and training issues
   - varied parameters
   - legal issues

Risk Assessment, Management, and Communication

1. Challenge: Uniform Signage
   Solutions:
   - apply standards nationally
   - develop on-site management of signs (size, content, and positioning distance)
   - define reopening procedures

   Barriers:
   - cost
   - reluctance to change
2. Challenge: Communication of Risk to the Public
   Solutions:
   - provide access to information on how simplified values (Green Light, Red Light) are derived for beach reporting (e.g., Heal the Bay, EMPACT web sites)
   - provide a decision tree showing how beach advisories/closings are determined
   - provide successful outreach documents as an appendix in the guidance
   - define the difference between an advisory and closing procedures
   - post fliers with lifeguards, surf shops, stores, hotels, fast food shops, and restaurants
   - encourage the use of hotlines and press release
   - educate lifeguards to reinforce postings and closings
   - define indicators for the public
   - educate upstream communities on the effects of water pollution (watershed approach)

   Barriers:
   - enforcement
   - mixed messages
   - costs
     - individual
     - society
   - public trust
3. Challenge: Getting Balanced Media Coverage
   Solutions:
   - develop guidance on successful ways to communicate with the media (case studies)

   Barriers:
   - media likes to control the message
   - lack of conclusive data
4. Challenge: Using Risk Assessment Assumptions
   Solutions:
   - present major caveats
   - use a weight-of-evidence approach with assessments
   - field test for accuracy

   Barrier:
   - assumptions lead to high uncertainty
5. Challenge: Lack of Problem "Visibility"
   Solution:
   - conduct a national campaign to increase beach issue awareness

   Barriers:
   - overreactions

- mixed-messages
- congressional constraint

6. Challenge: Risk Management

   Solutions:
   - Assess adequacy of BMPs for pathogens
   - diaper bans
   - adequate restroom facilities

Barriers:
- none identified

7. Challenge: Identification of Source Contamination

   Solutions:
   - provide lists of available tools (i.e., American Water Works Association)
   - provide guidance on sanitary surveys
   - develop additional methods to identify sources
     - DNA fingerprinting
     - RNA probes
     - tracers for sewage
     - sentinel organisms/mussels
   - recommend providing adequate restroom facilities
   - develop urban runoff versus storm water source issues

   Barriers:
   - lack of historical information on sites
   - costs

Recommendations to Include in the Guidance Document

1. Encourage consistency between surveys to limit duplication of effort (e.g., state, NRDC, EPA, GLNPO)
   - beach mile day
   - water quality data
   - beach names
   - consistent data transfer protocols
2. Define terms (define a *beach* versus a *swimming* area)
3. Include case studies
4. Develop sample handling procedures
   - need for longer storage
   - certify more laboratories
5. Include state-specific information and resources
6. Encourage states to conduct epidemiological studies
7. Hasten the approval process for approving indicators at EPA

Speakers' Biographies

Mark Anderson

Mr. Anderson is a biologist for the National Park Service and Director of the Beach Monitoring Program at Glen Canyon National Recreation Area in Page, Arizona. He received his B.S. in Biology and M.S. in Environmental Science at the University of North Texas in Denton, Texas. Mr. Anderson has been working in aquatic ecology and certified environmental laboratories for 8 years. He spent 4 years studying the effects of land use and industrial activity on playa wetlands in west Texas. His current work includes managing two certified laboratories at Glen Canyon National Recreation Area and developing a more scientifically sound beach-monitoring program for Lake Powell.

David Beckman

Mr. Beckman directs the water quality program in the Los Angeles office of the Natural Resources Defense Council, where he is a senior attorney. He received his A.B. from the University of California at Berkeley and his law degree from Harvard Law School. Mr. Beckman's work at NRDC focuses on matters relating to Clean Water Act enforcement, including storm water pollution control and TMDLs. Mr. Beckman has litigated major storm water enforcement actions against Caltrans and Los Angeles County and is currently representing NRDC, Santa Monica BayKeeper, San Francisco BayKeeper, and Heal the Bay with respect to TMDLs in California. Prior to joining NRDC in 1995, Mr. Beckman was in private practice in San Francisco for three years.

Steven Book, Ph.D.

Dr. Book is a toxicologist with the California Department of Health Services' drinking water program. He received his A.B. in Biological Sciences from the University of California at Berkeley and his M.A. in Zoology and his Ph.D. in Physiology from the University of California at Davis. He has held a number of positions in California's public health and environmental protection agencies, serving in various capacities in DHS, the Health and Welfare Agency, and Cal/EPA's Office of Environmental Health Hazard Assessment. Most of his work has been on the evaluation of public health risks from environmental contaminants, and the incorporation of scientific matters into public policy. Prior to joining state service, Dr. Book was on the research faculty of the University of California at Davis. He has also worked as an environmental consultant.

Al Dufour, Ph.D.

Dr. Dufour is currently the Director of the Microbiological and Chemical Exposure Assessment Research Division of the U.S. Environmental Protection Agency's National Exposure Research Laboratory. He earned his B.A. in Biology and Chemistry from Northern Michigan University, his Masters of Public Health specializing in epidemiology and environmental health services from Yale University, and a doctorate in microbiology from the University of Rhode Island. Dr. Dufour was with the U.S. Public Health service for four years and then joined EPA in 1970. His research interests are analytical microbial methods development; microbial risk assessments for recreational, drinking, and shellfish harvesting waters; and human exposure associated with waterborne and airborne microbial pathogens.

Sharon Dunwoody, Ph.D.

Dr. Dunwoody is Evjue-Bascom Professor and Director of the School of Journalism and Mass Communication at the University of Wisconsin-Madison. She earned her B.A. in Journalism from Indiana University, her M.A. in Mass Communication from Temple University, and a Ph.D. in Mass Communication from Indiana University. In addition to her journalism work at UW-Madison, she has been affiliated with the Institute for Environmental Studies, most recently serving as chair of academic programs there. A former newspaper science writer, Dr. Dunwoody has spent her research career studying aspects of public understanding of science. Her work in risk communication has focused on understanding how individuals use information to make judgments about risks. In the course of that work she has studied, among other things, the risks of eating contaminated fish caught in the Great Lakes, the risks posed by parasites in drinking water, and individuals' perceptions of their risk of being diagnosed with AIDS.

Mark Gold, Ph.D.

Dr. Gold is the Executive Director of the local environmental group Heal the Bay. Founded in 1985, Heal the Bay is a nonprofit group of more than 10,000 members working through a combination of research, education, public outreach, and advocacy to make Santa Monica Bay and Southern California's coastal waters safe and healthy for people and marine life. Dr. Gold completed his doctoral dissertation in UCLA's Department of Environmental Science and Engineering. He has worked on a wide variety of water quality and coastal natural resources issues ranging from sewage treatment to contaminated sediments to wetland restorations. Dr. Gold is considered one of the region's foremost experts on urban runoff pollution and he influences governmental water policy at the local, state, and federal levels.

Chris Gonaver

Mr. Gonaver received his B.S. in Microbiology from Iowa State University in 1971 and his M.P.H. from San Diego State University in 1985. He began his career in public health in 1975, when he joined the County of San Diego (as a public health microbiologist) where he worked for 12 years. In 1988, after graduating from San Diego State University, Mr. Gonaver joined the Department for Environmental Health, where he has been a manager for the past eight years. He currently manages the Land and Water Quality Division of the Department of Environmental Health, which is one of the Department's four divisions. His division is responsible for the county's recreational water quality, storm water permit compliance, oversight of the cleanup of contaminated underground storage tank sites and other hazardous waste sites, installation and removal of underground storage tanks, public health-related land use activities, and risk assessment and risk communication.

David Gray, P.E.

Mr. Gray is an environmental engineer with the Municipal Services Section of the Massachusetts Department of Environmental Protection (MDEP) He received his B.S. in

Civil Engineering from the University of Massachusetts at Amherst. He worked as a water resources engineer for 5 years with Camp Dresser & McKee on a variety of water quality monitoring and modeling efforts. In 1995, Mr. Gray founded Gray Environmental to provide storm water management and pollution prevention services with a focus on reopening impacted shellfish beds. For the past year, he has worked for the MDEP with an emphasis on storm water pollution abatement, wastewater, and CSO facilities planning.

Jake Joyce, Ph.D.

Dr. Joyce is currently assigned to the EPA Region 7 in Kansas City, Kansas. He is assigned to the Water, Wetlands, and Pesticide Division, where one of his ancillary duties involves being the regional BEACH Coordinator. He began his governmental career during the Viet Nam era as a green beret weapons specialist cross-trained as a medic. He then accepted a commission into the U.S. Public Health Service and was assigned to the U.S. Coast Guard in New York City as an environmental/occupational health officer. He has also served as a supervisory sanitarian for the Indian Health Service and an environmental health scientist for EPA's Toxic Substances and Disease Registry in Kansas City, Kansas. Dr. Joyce earned a bachelor's degree in general science from Marywood College in Scranton, Pennsylvania and a master's degree in environmental biology from Hood College Graduate School in Frederick, Maryland. He also holds another masters degree in environmental health science and a doctorate in environmental health science from New York Polytechnic in Brooklyn, New York.

Charles McGee

Mr. McGee has worked in the field of environmental microbiology and virology since 1972. He holds degrees from Louisianan State University in Baton Rouge and Pepperdine University in Malibu, California. He received virology training at Baylor College of Medicine in Houston, Texas. Mr. McGee worked as a member of an environmental virology consulting group in upstate New York from 1974 to 1978, as the virologist for the Los Angeles County Sanitation District from 1978 to 1990, and then from 1990 until now as the laboratory supervisor in charge of microbiology at the Orange County Sanitation District, Orange County, California. Mr. McGee is a member of the Microbiology Advisory Committee to the California State Water Resources Control Board on California Ocean Plan Bacterial Objectives; a member of the Technical Advisory Committee to the Santa Monica Bay Restoration Project, a coauthor of the Santa Monica Bay Restoration Project Epidemiology Study; and a participant in the World Health Organization/EPA Expert Consultation on Safety of Recreational Waters last November. He has participated in environmental research investigations at the University of California, Irvine, University of Arizona, Tucson, University of North Carolina, Chapel Hill, and University of Hawaii, Honolulu.

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Dr. Noble is a postdoctoral scientist for both the Southern California Coastal Water Research Project and the USC Wrigley Institute Environmental Studies. She received her B.S. in Molecular Biology from Carnegie Mellon University in Pittsburgh, Pennsylvania, and a Ph.D. in Marine Biology from the University of Southern California. There her dissertation research focused on the roles of native marine viruses in biogeochemical cycling, with emphasis on degradation and microbial uptake of degraded virus material. As a Sea Grant Trainee, she also performed research on the molecular detection of human enteric viruses in seawater. Dr. Noble is currently working on optimization of methods for Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) detection of enteric viruses and researching the relation of viral indicators to bacterial indicators in coastal waters. Her current research interests include the advancement of methods for viral detection, dynamics of viruses in marine microbial food webs, and new biomarker techniques for bacterial and viral pathogens in coastal waters.

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Mr. Rosenblatt is the chief of the Atlantic Coastal Bureau, Division of Watershed Management, in the New Jersey Department of Environmental Protection. He received his B.S. in Environmental Science from Rutgers University and M.A. in Teaching from the College of New Jersey. For the past 20 years, he has evaluated nearshore coastal water quality and developed pollution response and remediation programs, including New Jersey's Cooperative Coastal Monitoring Program for recreational beaches. Mr. Rosenblatt continues to manage beach quality programs in addition to watershed planning and management in the Atlantic coastal region.

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Dr. Schaub joined the EPA's Office of Science and Technology in 1992 as a senior microbiologist for drinking water regulation support. He coauthored EPA's Beach Action Plan and served as the EPA representative to the President's Council on Food Safety. Prior to joining EPA, Dr. Schaub served as a microbiology program officer for the U.S. Army Medical Research and Development Command from 1972 to 1992 in field water supply and sanitation. He worked on microbiological method, military equipment evaluation, and effectiveness, of land application of wastewater. Dr. Schaub also studied microbiological pollution in the Great Lakes with the U.S. Public Health Service from 1964 to 1966. He holds a B.S. in Microbiology from Washington State University and a Ph.D. in Microbiology from the University of Texas.

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East Coast Regional Beach Conference

October 18-19, 1999

Tampa, Florida

Proceedings

East Coast Conference Agenda

Goals: To provide a forum for all levels of beach water quality managers and public health officials to share information and provide input on the future directions of EPA's BEACH Programs.

Objective:
1) Present EPA's BEACH Program.
2) Present the state of the science.
3) Discuss local and regional water quality management issues through case study presentations.
4) Obtain feedback on major topic areas for EPA's Beach Guidance document.

Monday, October 18–Day 1

8:00-9:00 **Registration**

9:00-9:10 **Welcome**
Rick Hoffmann
USEPA, Office of Water, Standards and Applied Science Division

9:10-9:25 **Water Quality Issues in the Gulf of Mexico**
Fred Kopfler
USEPA, Gulf of Mexico Program Office, Region 4

9:25-11:20 ***Session 1: Water Quality Standards, Indicators, and Implementation***

9:25-9:45 **Overview of Water Quality Indicator Microbes**
Jake Joyce
USEPA Region 7

9:45-10:05 **Boston Harbor/Charles River Beach Monitoring Effort: Comparison of Two Indicator Methods**
Matt Liebman
USEPA Region 1

10:05-10:25 **New Indicators of Water Quality for Recreational Water Use**
Steve Schaub
USEPA, Office of Science and Technology

10:25-10:40 **BREAK**

10:40-11:00 **New Tools for Assessing Healthy Beaches**
Joan Rose
University of South Florida

11:20-12:00 **EPA's Beach Plan**
Geoffrey Grubbs, Director
USEPA, Office of Science and Technology

11:00-11:20 **Q & A/Discussions**

12:00-1:30 **LUNCH**

1:30-3:30 ***Session 2: Risk Assessment, Exposure, and Health Effects***

1:30-2:00 **The Relationship of Microbial Measurement of Beach Water Quality to Human Health**
Al Dufour
USEPA, National Environmental Research Laboratory

2:00-2:20 **Qualitative Review of Epidemiology Studies**
Tom Mahin
Massachusetts DEP

2:20-2:40 **Epidemiological Research on Bather Illness and Freshwater Microbial Contamination**
Rebecca Calderon
USEPA, Office of Research and Development

2:40-3:10 **Q & A/Discussions**

3:10-3:30 **BREAK**

3:30-5:30 ***Session 3: Monitoring and Modeling***

3:30-3:50 **Indiana's *E. coli* Interagency Task Force**
Arnold Leder
USEPA Region 5

3:50-4:10 **Predictive Modeling of Bacterial Indicators Along the South of Lake Pontchartrain**
Jeff Waters
Lake Pontchartrain Basin Foundation

4:10-4:30 **A Regional Modeling Tool for Impacts of Spills and Bypasses**
Phil Heckler
New York City Department of Environmental Protection

4:30-5:00 **New Jersey's Recreational Monitoring Program**
David Rosenblatt
New Jersey Department of Environmental Protection

5:00-5:30 **Q & A/Discussions**

Tuesday, October 19–Day 2

8:30-8:45 **Summary of Day 1**
Geoffrey Grubbs, Director
USEPA, Office of Science and Technology

8:45-9:05 **Great Lakes Monitoring Program**
Paul Horvatin
USEPA, Great Lakes National Program Office, Region 5

9:05-9:20 **Factors Affecting *Escherichia coli* Concentrations at Lake Erie Public Bathing Beaches**
Donna Francy
USGS, Ohio District

9:20-11:20 Session 4: Beach Advisories, Closures, and Risk Communication

9:20-9:50 **Recreational Rates, Fish Consumption, and Communication**
Joanna Burger
Rutgers University, Department of Biological Sciences

9:50-10:10 **Florida's Beachwater Web Site**
Robert Nobles
Florida Department of Health, State Health Office

10:10-10:30 **Florida Monitoring and Coordination Efforts**
Paul Stanek
Florida Department of Health, Pinellas County

10:30-11:10 **Q & A/Discussions**

11:10-11:15 **Organization of Breakout Groups**
Purpose: Discuss the major components of the Beach Guidance. Provide recommendations and key elements to be included in the document.

11:15-11:30 **Break**

11:30-12:30 **BREAKOUT SESSIONS CONVENE**

12:30-1:30 **LUNCH**

1:30-3:30 **BREAKOUT SESSIONS CONTINUE**

3:30-4:30 **Open Discussion and Information Synthesis**

4:30-4:45 **Closing Remarks and Adjourn**
Geoffrey Grubbs, Director
USEPA, Office of Science and Technology

Welcome

Rick Hoffmann
US Environmental Protection Agency, Office of Science and Technology

Mr. Hoffmann welcomed the audience and noted that this was the second of two regional beach conferences. He also noted the changes to the agenda. More than 200 people registered for this conference, and the participants were evenly distributed from Maine to Florida and the Great Lakes states. Other participants came from as far as Canada, Trinidad, and Palau.

The purpose of the conference was to provide a forum for beach water quality managers to talk about water quality issues such as issuance of beach advisories, monitoring, and notification to assist EPA in the development of a program to protect the public from microbial pathogens in recreational waters. The conference was designed to allow sharing of information about the current state of the science for water quality standards, disease indicators, risk assessment, and risk communication. It was also to provide a forum for presenting local and regional issues through case studies. EPA is in a "listening mode" prior to developing useful guidance related to recreational beach programs. EPA will use the recommendations from this conference and the West Coast Conference (which was held in San Diego, California, on August 31 and September 1) in the development of the guidance document later this year.

Water Quality Issues in the Gulf of Mexico

Fred Kopfler
US Environmental Protection Agency, Gulf of Mexico Program Office, Region 4

Water quality is a very important issue in the Gulf. Tourism is a $20 billion industry based on the beaches and gambling. Gambling is extensive in Mississippi, where the casinos are on barges adjacent to the land. The area was once a sleepy back-water area, but it is not that anymore. The population in Mississippi has increased 30 percent since 1969 when hurricane Camille hit.

Most of the land surrounding the Gulf is wetlands. Rapid growth presents a problem for sewage treatment. Sewage tends to bubble to the surface and overflows in most areas because of the wetland environment. Determining the presence of sewage and microbial pathogens in recreational waters is a big area of concern for the Gulf.

In the Gulf Coast area, there are 95 8-digit watersheds, 93 of which have a least one segment impaired due to the presence of fecal coliform or other pathogens. Approximately 800 segments are not meeting their designated uses due to pathogens. It will be interesting to understand how monitoring recreational waters using new indicators will relate to the ambient water quality monitoring program, since the TMDLs are all based on fecal coliforms.

The shellfish program is also an issue. The Gulf of Mexico provides most of the shellfish to the United States. The program is overseen by the Food and Drug Administration, and they are adamant about using fecal coliforms as their indicator. They also use the MPN method for enumerating fecal coliforms. Since EPA is responsible for making sure waters meet their designated uses, if the shellfish waters are impaired based on fecal coliforms it will be interesting to see how this will all work out. Beach monitoring and new indicators are a very important issue. This problem will need to be addressed in the future, and this conference will help facilitate these types of discussions.

Session One: Water Quality Standards, Indicators, and Implementation

Overview of Water Quality Indicator Microbes

Jake Joyce
US Environmental Protection Agency, Region 7

Please refer to page 11 in the West Coast Conference Proceedings.

Boston Harbor/Charles River (MA) Beach Monitoring Efforts: Comparison of Two Indicator Methods

Matthew Liebman
US Environmental Protection Agency, Region 1

Mike Galvin[1], Paul Dipietro[1], Diana Liu[2], Kathy Baskin[3]
[1] Metropolitan District Commission, Boston, MA, [2] G and L Laboratories, Quincy, MA, [3]Charles River Watershed Association

Boston Harbor and the Charles River are affected by sewage-derived pathogens from illegal sewer connections, storm water, combined sewer overflows, and poorly treated sewage. Although improving in quality, Boston Harbor beaches are posted many times per year and the lower Charles River frequently violates state water quality standards for fecal coliform contamination during wet weather. The overall goal of this EMPACT (Environmental Monitoring for Public Access and Community Tracking) program, and BEACH program-funded project was to rapidly convey to the public whether Boston Harbor beaches are safe for swimming and the lower Charles River is safe for boating.

In the Boston Harbor area, the Metropolitan District Commission (MDC) routinely samples 16 saltwater and 4 freshwater beaches for enterococci and fecal coliform on a weekly basis during the summer. The samples are collected on Wednesdays (through 1998) in preparation for the weekend, with resampling until densities are below established thresholds (e.g., 104 enterococci colonies/100 mL for saltwater beaches). Some historically contaminated beaches are sampled on a daily basis. In the lower Charles River basin, the Charles River Watershed Association (CRWA) routinely samples from four or five stations at or near boathouses for fecal coliform and enterococci five days per week. The MDC reports results to the public as swimmer's advisories by flags posted at the beach and via the Internet, telephone and newspaper. The CRWA reports numerical results on a daily basis on its Internet web site and posts boater's advisories at boathouses with similarly designed flags (blue = safe, red = use caution).

Since 1986, EPA has recommended the use of enterococci bacterial density as a better indicator of fecal contamination in recreational waters. Recently, EPA developed a new enterococci membrane filtration method—EPA Method 1600—that reduces incubation time from 48 hours to 24 hours (U.S.EPA, 1997). As part of the first year of the EMPACT project, we field tested the new method using an MDC contract laboratory. We compared Method 1600 (mEI medium) to the existing test (EPA Method Number 1106.1, mE medium, U.S.EPA, 1985) based on statistical tests, specificity, and cost-effectiveness. We designed this field test to be consistent with EPA's alternative method testing protocols and the approach described in Messer and Dufour (1998). Samples were split in the laboratory. Verification (specificity) of enterococci identification was performed to determine the percentage of false positives and false negatives. We performed a paired t-test on both untransformed and natural log-transformed values and examined the data using correlation and linear regression.

In 1998, we sampled weekly for 11 consecutive weeks at 14 sites at five beaches in Boston Harbor and one freshwater pond (Houghton's Pond) under dry and wet weather conditions. In the Charles River, we sampled at four or five stations on 25 separate days from May to October spanning a range of rainfall conditions. The total number of paired samples was 272 (Boston Harbor: n = 132; Houghton's Pond: n = 22; and Charles River: n = 118).

Overall, there was fundamentally no difference between the two methods. The Pearson correlation coefficients for Boston Harbor, Houghton's Pond and Charles River samples (natural log-transformed) were 0.85, 0.80, and 0.93, respectively. For Boston Harbor, the geometric means were similar (8.1 [Method 1600] vs. 7.6 [standard]). There was no significant difference between the methods based on a statistical comparison of untransformed and natural log-transformed values, using the paired t-test for all samples. However, examination of the data graphically indicated Method 1600 values were higher than the standard method when the mean density of the two methods was above 70 colonies/100 mL. Based on a paired t-test, when the mean was above 70 colonies/100 mL, Method 1600 resulted in significantly higher values ($p < 0.01$, $n = 17$). It is possible that Method 1600 is more selective at detecting enterococci colonies, but there was no difference in false positive (2 percent and 4 percent) or negative rates (7 percent and 8 percent) for Method 1600 and the standard method, respectively.

Because the MDC posts Boston Harbor beaches when enterococci density exceeds 104 colonies/100 mL, there may be a slight increase in number of postings. In only two samples (of 132 saltwater samples) both methods predicted an exceedance. In seven samples Method 1600 predicted an exceedance when the standard method did not, and on one occasion the standard method predicted an exceedance when Method 1600 did not.

Based on these results, the MDC replaced the existing test in 1999 with Method 1600. Because of the reduced incubation time, the MDC now samples on Thursdays instead of Wednesdays. The increased cost to the MDC of the new method ($20 per sample compared to $17 per sample) was balanced by the reduced number of days required to resample a beach before a weekend. The MDC uses both fecal coliform and enterococci measurements in determining whether to post a beach. Now that the enterococci incubation time is in line with the fecal coliform method, the beach sampling program is more cost-effective and protective of public health.

References

Messer, J.W., and A.P. Dufour. 1998. A rapid, specific membrane filtration procedure for enumeration of enterococci in recreational water. *Applied and Environmental Microbiology* 64(2):678-680.

USEPA. 1985. *Test Methods for* Escherichia coli *and Enterococci in Water by the Membrane Filter Procedure.* EPA/600/4-85/076. U.S. Environmental Protection Agency, Office of Research and Development. Washington, DC.

USEPA. 1997. *Method 1600: Membrane Filter Test Method for Enterococci in Water.* EPA 821-R-97-004. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Boston Harbor/Charles River (MA) Beach and River Monitoring

A comparison of two bacteria indicator (Enterococci) methods

Matthew Liebman, US EPA Region I, New England
Mike Galvin and Paul DiPietro, MDC (Boston, MA)
Diana Liu, G and L Laboratories (Quincy, MA)
Kathy Baskin, CRWA (Newton, MA)

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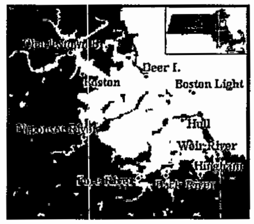
Boston Harbor and Charles River



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Boston Harbor and Charles River Background

- Boston Harbor and Charles River polluted by fecal-contaminated point and nonpoint sources
- Foci of major cleanup efforts
- Boston Harbor and Charles River are major recreational resources swimming, boating, crew, sailing
- Public demands safe swimming and rowing opportunities
- Exposure to pathogen related pollution varies on a daily basis

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EMPACT Project Goals

- Protect public health with routine monitoring of enterococci and fecal coliform
- Inform public within 24 - 30 hours in a variety of media, including Internet, television, newspaper, telephone and FLAGS
- Field test new EPA Method 1600
- Evaluate use of Polymerase Chain Reaction (PCR) as monitoring tool
- Transfer technology to local state laboratory
- Develop rainfall predictors

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EMPACT Project Accomplishments

- Routine monitoring ongoing
- Public notified within 30 hours of sampling
- Flagging and media coverage ongoing and successful
- Method 1600 field tested
- PCR technology in development
- Tech transfer to state laboratory delayed
- Rainfall predictor study ongoing (MWRA)

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Metropolitan Boston Routine Monitoring Programs

- Boston Harbor area (MDC):
  - 21 beaches, 38 sites including freshwater ponds
  - routinely sampled on Wednesdays and Thursdays to prepare for weekend
  - 7 days per week at four historically contaminated sites
  - enterococci, fecal coliform
  - 24 - 48-hour turnaround in 1998, 24-hour turnaround in 1999
- Lower Charles River (CRWA)
  - 5 sites, at boathouses or bridges
  - routinely sampled Monday thru Friday
  - sampled by volunteers (in 1998) or staff (in 1999)
  - enterococci, fecal coliform
  - 24 - 48-hour turnaround in 1998, 24-hour turnaround in 1999

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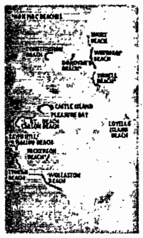
Boston Harbor SW sampling stations

(Source: www.mwra.state.ma.us/harbor/)



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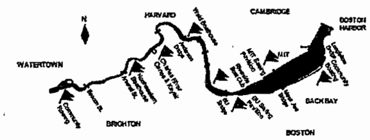
Lower Charles River sampling stations

(Source: www.crwa.org)



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Methods

- Boston Harbor 1998
  - split samples from 14 stations, 11 weeks June through August
  - tested for new Method 1600 (mEI medium) and EPA Method 1106 (standard method, using mE medium) and fecal coliform
  - N = 132 in Boston Harbor, N = 22 in Houghton's Pond
  - range of rainfall conditions
- Charles River 1998
  - split samples from 5 stations, 25 separate events May through October
  - tested for new Method 1600 (mEI medium) and EPA Method 1106 (standard method, using mE medium) and fecal coliform
  - N = 118
  - range of rainfall conditions

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Statistical tests and specificity

- Verification (= specificity) of enterococci identification
  - Method 1106 mE medium: 78 positive colonies and 63 negative colonies
  - Method 1600 mEI medium: 83 positive colonies and 71 negative colonies
- Paired t-test of untransformed and natural log-transformed values
- Correlation (Pearson product correlation coefficient)
- Linear regression
- Calculation of RPD (relative percent difference)
- Analysis of field and laboratory duplicates

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Geometric means of bacterial indicators, 1998

	Sample size	Method 1106 (mE medium)	Method 1600 (mEI medium)	Fecal coliform
Boston Harbor	132	7.6	8.2	35.9
Houghton's Pond	22	14.4	11.1	130.3
Charles River	113	34.8	29.4	379.9

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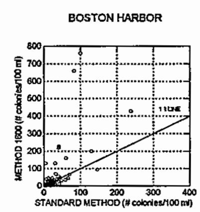
Correlation of both methods



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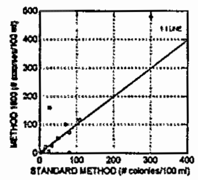
Correlation of both methods



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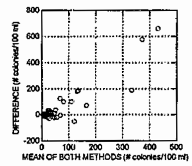
Difference vs. mean



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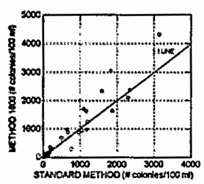
Correlation of both methods



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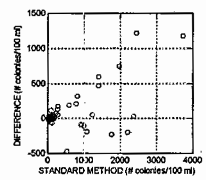
Difference vs. mean



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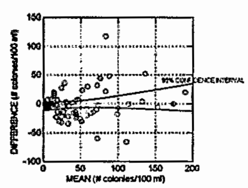
Difference vs. mean (<200 colonies/100 ml)



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Statistical tests

	Paired t-tests for natural log-transformed values N	p	Pearson correlation coefficient natural log-transformed values R
Boston Harbor (all samples)	132	0.34	0.845
Boston Harbor (< 70 colonies)	123	0.80	0.801
Boston Harbor (> 70 colonies)	9	0.02 *	0.273
Houghton's Pond	22	0.25	0.801
Charles River	113	0.03 *	0.928

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Number of times sample exceeded criteria

SW criterion = 104 colonies/100 ml; FW criterion = 61 colonies/100 ml

	Sample size	Method 1106 only	Method 1600 only	Both
Boston Harbor	132	1	7	2
Houghton's Pond	22	3	1	3

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Specificity Boston Harbor/Houghton's Pond 1998

	False positive (%)	N	False negative (%)	N
Method 1106 (mE medium)	4	78	8	63
Method 1600 (mEI medium)	2	83	7	71

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Relative percent difference Boston Harbor 1998 only

	RPD (%)	
Laboratory	1998 (n=19)	1999 (n=18)
Fecal coliform	32.2	2.2
Method 1106 (mE medium)	15.9	--
Method 1600 (mEI medium)	--	7.5
Field	1998 (n=11)	
Method 1106 (mE medium)	38.7	
Method 1600 (mEI medium)	45.2	

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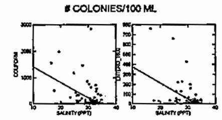
Relationship to salinity



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Conclusions

- When enterococci densities are high (>70 colonies/100 ml), Method 1600 gives significantly higher values than standard method in Boston Harbor, but also to some degree in freshwater as well
- Slight increase in postings in Boston Harbor area beaches may result
- But, specificity between the two methods is similar and acceptable (< 10%)
- Increased cost of new method compensated by fewer number of sample days needed
- 24-hour turnaround time aligns with fecal coliform method
- MDC used Method 1600 in 1999 on Thursdays and Fridays

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October 1999

EPA Region I, New England

New Indicators of Water Quality for Recreational Water Use

Steve Schaub
US Environmental Protection Agency, Office of Science and Technology

Please refer to page 21 in the West Coast Conference Proceedings.

New Tools for Assessing Healthy Beaches

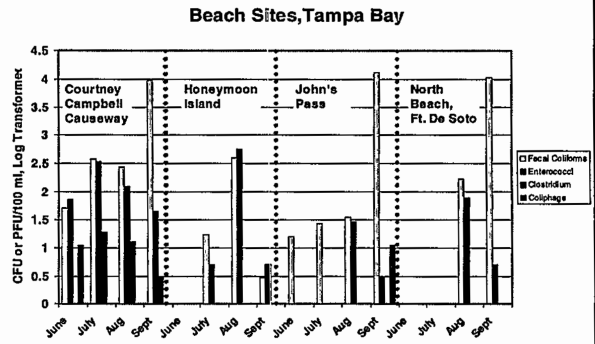
Joan Rose
University of South Florida, Department of Marine Sciences

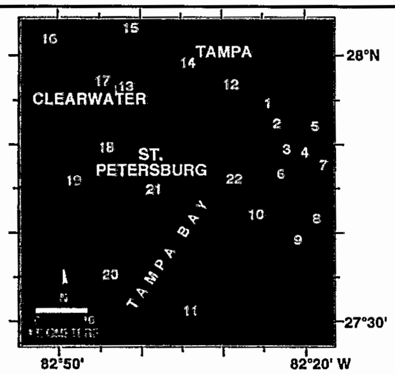
Recreational waterborne disease can result from water contamination from numerous sources, including human and animal wastes, urban runoff, industrial pollution, wastewater, storm waters, large concentrations of bathers, and even from indigenous sources such as red tide. While historically the focus of monitoring has been on enteric diseases such as those causing diarrhea, of even greater concern are infections of the skin, wounds, respiratory and genital tracts, eyes, and ears. Transmission of diseases has been documented from individuals swimming, wind surfing, and even boating in or on polluted waters. Concern for such transmission has been heightened with the emergence of new pathogens (e.g., *E. coli* and *Cryptosporidium*), antibiotic-resistant strains, and a more susceptible population (due to more elderly, AIDS, and immune suppressant medical treatments). Public health and safety are tied to the understanding of sources of pollution, so that prevention and remediation can be accomplished and timely (preferably advance) public information can be made available. The keystone of any effort is the measurement of water quality and protection of these waters from pollution.

Clean beaches and the recreational activities associated with them form the backbone of the tourist industry in Florida; however, most of Florida may be classified as a tropical water. There are significant concerns the water quality indicators in general use do not faithfully reflect pollution and public health concerns. Also, decisions are based on local interpretations as to what level should result in a beach closure. The limitations of total and fecal coliforms in recreational waters, particularly subtropical waters, are now well recognized. Other indicators such as Enterococcus, *Clostridium perfringens*, and bacteriophages (viruses that are parasites of bacteria) have been suggested, but each appears to have its own limitations when relied upon to indicate the presence of human pathogens such as Staphylococcus, Pseudomonas, and viruses. A multipronged approach is required, perhaps with a suite of indicators coupled with pathogen monitoring. The goals of this program are to establish criteria, protocols, and monitoring plans for integrated management strategies to be used for assessment and response to public health concerns for subtropical beaches in Florida and the U.S. Using a scientifically based risk-assessment approach, land use, sources, climate factors and broad water quality monitoring can be used to address appropriate management strategies in the future.

New Tools for Assessing Healthy Beaches

Joan Rose
University of South Florida



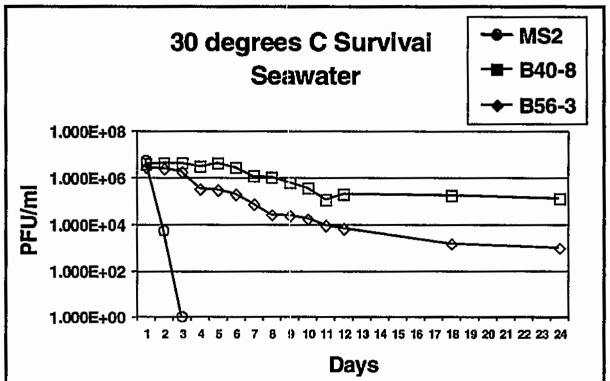


B. fragilis Bacteriophage

- Siphoviridae, double-stranded DNA
- Flexible tail
- Somatic phage
- Found in 13% of human population
- B40-8 (ATCC 51477) human strain
- B56-3(RYC2056) animal and human strain

B. fragilis phage B40-8 (ATCC 51477)

- TB1 Delaney Creek
- TB7 Bullfrog Creek (Little B.F. headwaters)
- TB12 Hillsborough River
- TB17 Allen's Creek



Sampling Sites

- TB1 Delaney Creek
- TB2,5 Alafia River
- TB3,4,6,7,8 Bullfrog Creek
- TB9,10 Little Manatee River
- TB11 Manatee River
- TB12 Hillsborough River
- TB13 Courtney Campbell Causeway
- TB14 Sweetwater Creek
- TB15 Tarpon Lake Canal
- TB16 Honeymoon Island
- TB17 Allan's Creek
- TB18 Joe's Creek/Cross Bayou
- TB19 John's Pass
- TB20 North Beach, Ft. DeSoto
- TB21 Salt Creek
- TB22 Control Site-Middle of Bay

B. fragilis phage B56-3 (RYC2056)

- TB1 Delaney Creek
- TB3, 4, 6, and 8 Bullfrog Creek
- TB5 Alafia River at 301
- TB12 Hillsborough River
- TB14 Sweetwater Creek
- TB17 Allen's Creek
- TB18 Joe's Creek/Cross Bayou
- TB21 Salt Creek
- (TB 4 and 6 have tested positive for both Aug and Sept)

EPA's Beach Plan

Geoffrey Grubbs
US Environmental Protection Agency, Office of Water

EPA is holding this conference to provide a forum for beach water quality managers and public health officials to share information and to provide input that will assist the Agency in development of a program to protect the public from microbial pathogens in recreational waters.

EPA has several objectives for this conference. The first is information sharing. We want to present our ongoing and planned recreational waters program activities and to present information that describes the current "state of science" in recreational water standards, disease indicators, risk assessment, monitoring, and risk communication. We also want to discuss local and regional recreational water quality issues through some case study presentations. Second, EPA wants your feedback on development of national guidance. The guidance document will address public health issues at U.S. beaches and establish nationally consistent beach monitoring and notification programs. We want to hear from the state and local perspective what would help you in developing your beach program.

In May 1997 EPA Administrator Carol Browner announced the establishment of the BEACH Program in response to concerns about water quality in recreation areas. BEACH is an acronym for Beaches Environmental Assessment, Closure, and Health Program. The program was developed as part of the Clean Water Action Plan, an effort to enhance the quality and improve protection of the Nation's waters. EPA spent a year developing its *Action Plan for Beaches and Recreational Waters* to address concerns and chart the Agency's future directions. The Beach Action Plan identifies EPA's multiyear strategy for monitoring recreational water quality and communicating public health risks associated with pathogen-contaminated recreational rivers, lakes, and ocean beaches.

Five concerns are identified in the Beach Action Plan. The first concern is persistent beach water quality problems, evidenced in beach closings and advisories. In 1997 the Natural Resources Defense Council's 8th annual survey on beach water quality reported 4,153 days of beach closings and advisories caused by pollution. EPA's annual National Health Protection Survey of Beaches, completed in 1998 and 1999, indicated that many beaches continue to have water quality problems. In 1999 EPA gathered information on more than 1,000 east coast, west coast, and Great Lakes beaches. Approximately 25 percent of these beaches were associated with an advisory or closing at some time during the year.

The second concern identified in the Beach Action Plan is substantial inconsistency in monitoring approaches among and within states. EPA's National Health Protection Survey of Beaches has confirmed that a wide variety of standards and monitoring approaches are used at beaches throughout the United States. In 1998 only one-third of survey respondents reported using *E. coli* or enterococcus as an indicator organism. The third concern identified in the Beach Action Plan is inconsistency in beach posting and notification programs. EPA surveys have indicated that, because of varying resources and diverse local circumstances, the local agencies (county health departments and sanitation districts) responsible for notifying the public of water quality problems use a wide range of risk communication practices (web sites, newspaper, radio). Some of these methods do not effectively communicate health risks to the public.

The fourth Beach Action Plan concern is awareness of the health risks posed by exposure to microbiological contaminants. It is a fact that recreational water users are at risk of infection from waterborne pathogens through ingestion or inhalation of contaminated water or though contact with the water. Some people might face a disproportionate risk from exposure to the pathogens because of heightened susceptibility. For example, children may be more vulnerable to environmental exposure because of their active behavior and developing immune systems. We need to focus research efforts to better understand the health effects of these microbial pathogens.

The fifth concern identified in the Beach Action Plan is stress placed on coastal ecosystems by human population growth and development. In the United States, it is estimated that 75 percent of the population will live within 1 hour of the coast in the next 10-20 years. Habitat destruction and pollution resulting from this future coastal development and growth will have a great impact on the coastal ecosystems. It is a goal of scientists not only to discover means of pollution prevention, but also to derive reproducible methods to better assist environmental managers in monitoring and improving coastal water quality.

An important part of the Beach Action Plan is to assist in state, tribal, and local implementation of monitoring and public notification programs. EPA will strengthen water quality standards implementation programs by establishing appropriate policies (e.g., what should be done in tropical waters) and assisting local managers in their transition to EPA's currently recommended Ambient Water Quality Criteria for Bacteria. The transition to EPA's current water quality criteria will be a priority for the triennial water quality standards reviews to be completed in FY2000-2002. Beginning in FY2000, EPA will develop management agreements with the states and tribes that will include commitments to have states and tribes adopt the current criteria. Where a state does not amend its standards to include the 1986 criteria, EPA will act to promulgate the criteria with the goal that they apply in all states not later than 2003.

As part of the Beach Action Plan, EPA is also coordinating the planning and issuance of national BEACH Program guidance documents. The guidance document, entitled *National Monitoring and Notification Guidance for Recreational Beach Managers*, will address recreational water quality monitoring, risk assessment, risk management, and risk communication. The document is heavily developed with input from state and local government agencies. This conference will assist us in developing the guidance.

EPA is taking a number of other steps to implement the Beach Action Plan. The agency will continue to conduct the annual National Health Protection Survey of Beaches. EPA uses the survey to collect detailed national data on state and local beach monitoring efforts, applicable standards, beach water quality communication methods, the nature and extent of beach contamination problems, and any protection activities.

Surveys have been completed during each of the past 2 years, and the results have been made available to the public on EPA's Beach Watch Internet web site, www.epa.gov/ost/beaches. EPA will continue to maintain this web site to provide timely recreational water quality information to the public and to local authorities. The current web site will become a real-time electronic database with links to state and local beach health-related information. The web site will also provide information identifying those beaches where monitoring and assessment activities are conducted in a manner consistent with EPA's national guidance. An important part of EPA's effort to make beach information available to the public is to develop a national digitized inventory of beach maps. EPA will develop a protocol for mapping beaches and will begin mapping in priority areas. These maps will ultimately be linked to the locations of pollution sources through a geographic information system.

EPA has recognized the need for developing better and faster indicators of water quality. Indicators are needed to identify risk before exposure takes place and to determine the potential presence of pathogens causing nonenteric diseases. Work has begun to complete research necessary for development of new indicators.

In modeling and monitoring research, a number of mathematical models have been or are being developed to assess the pollution in recreational waters. These models can be used to rapidly determine public health risks at beaches following rainfall events or spills. EPA has catalogued a range of predictive tools and is improving them. A catalogue and evaluation of existing models is available on EPA's Beach Watch web site. Models can range from rules of thumb for predicting risks, such as the occurrence of intense rainfall, to complex hydrodynamic models.

Research is planned to investigate the risks of combined sewer overflows, the role that interstitial waters play in microbial exposure to bathers (particularly children), human exposure factors (such as inhalation, skin contact, time spent in the water, and skin abrasions or cuts, and crowding of swimmers at small recreational areas) that contribute to adverse health effects. EPA has identified a need for epidemiological studies to establish a link between water quality indicators and disease endpoints. New and innovative indicator methods will be used to assess and validate their efficiency for determining health risks.

EPA activities have taken on greater prominence because Beach Program legislation has been proposed in the U.S. Congress. The House of Representatives passed H.R. 999, the Beaches Environmental Awareness, Cleanup and Health Act, sponsored by Congressman Bilbray. Senator Lautenberg has introduced a similar beach bill (S. 522). The Senate may take action on a bipartisan bill (either H.R. 999 or S. 522) during the next session. General Provisions of Beach Legislation include a requirement for adoption of revised state water quality standards consistent with EPA's current ambient criteria for bacteria (i.e., *E. coli* or enterococcus) within 3½ years, establishment of state or local beach monitoring and notification programs, and issuance of grants to state and local governments to support monitoring and notification programs. The passage of these bills will spur the development of a national beach program.

Question-and-Answer Session

Panel: Jake Joyce, Matt Liebman, Steve Schaub, Joan Rose, and Geoffrey Grubbs

Q (Lou Glatzer, University of Toledo): This question is for Dr. Rose. What was the mechanism by which you were measuring these parameters by Polymer Chain Reaction (PCR)? What was the definition of the parameter for bacteriophages, Clostridium, *and so forth?*

Joan Rose:

The indicators were all done with membrane filtration and cultivation techniques.

Q (Lou Glatzer): But you were showing quantitative levels.

Joan Rose:

Yes. For the indicators, it was membrane filtration cultivation techniques for *Clostridium*, enterococci, and coliphage. PCR was only for the human viruses. In some of our studies, we used cell culture for the human viruses and we did get quantifiable numbers. The PCR for the human viruses was taken from a concentrated sample. Part of the sample was put on cell culture for analysis by routine CPE, and part of the concentrate then was assessed with a variety of primer sets for the human viruses. That was presence/absence only.

Q (James Woodley, USEPA Headquarters, Oceans and Coastal Protection Division): This question is for Dr. Rose. You mentioned some potential causes of microbial contamination. Did you look at other studies that have been or are currently looking at the correlation between recreational and commercial boating and fecal contamination?

Joan Rose:

That is certainly a source of contamination at certain sites in the Tampa Bay area. To my knowledge, we have not investigated whether a marina itself or a high-use boating area is a high risk. Clearly the John's Pass area, which we are investigating, is a very high transit area for boats coming out of the upper reaches of the Bay and into the Gulf. We're hoping to understand the sources, and we have a variety of sites. I don't know of other studies that are being done like that, but that's a really difficult question to get at and I think it's an important one. It's a nonpoint source that's problematic.

Q (Helena Solo-Gabriele, University of Miami): This question is for Jake Joyce. You made a statement indicating that E. coli *was an ideal indicator because it doesn't grow outside the body. Is that a strong statement or is there evidence to indicate that it doesn't or are things starting to change?*

Jake Joyce:

I've seen some papers from the state of Hawaii where they were looking at the fecal coliforms and some *E. coli.* I am not certain if *E. coli* could have been still viable if it is bird or animal droppings and not necessarily in human contamination. Historically, we believe that *E. coli* is not an environmental microbe like *Serratia* or some of the other ones. There is recent evidence in tropical areas that some of these things can live in leaf litter if it is well fertilized.

Q (Helena Solo-Gabriele): Is there evidence that it doesn't grow in nontropical environments?

Jake Joyce:

I am not certain. Can someone help us out? *[No comments from the audience.]* Here is an area of future research.

Q (Bob Howard, Connecticut Department of Public Health Laboratory): My question is for the EPA representatives. Right now, EPA recommends E. coli *and enterococci as the indicator organisms. Do you see in the future that EPA will mandate specific laboratory procedures to be used for these indicators, as they do in the Drinking Water Program?*

Steve Schaub:

We think that the current indicators are the best that are available right now for making sure that public health is practiced appropriately and that we are protecting the health of our beaches goers. For the new indicators, I would anticipate that there will be a standardization process that will occur through our Office of Science and Technology. New methods are required to go through collaborative testing to establish the precision, bias, and accuracy and bias of any new methods that are deemed equivalent to the existing methods. I think this will be a continuing requirement for any indicator to supplant or be utilized as a replacement for *E. coli* or enterococci. We want to make sure that if we do come up with a new indicator, it is risk-based, and the indicator replacement must demonstrate the same pathogen loading that we have currently identify with the *E. coli* or enterococci - at least for our current approach and criteria. If we are talking about new indicators for different sets of diseases or pathogens that are currently targeted, they also will have to go through a development process, collaborative testing, and then epidemiological studies to demonstrate the risk correlation of the indicator versus the types of diseases which it is supposed to indicate for that type of waterbourne exposure.

Q (Arnie Leder, USEPA, Region 5): This question is for Jake Joyce. After E. coli *is discharged from a failed septic system or a wastewater treatment plant and not properly disinfected, what kind of a life span or life cycle does it have in the water? How long can you reasonably expect it to last, particularly in freshwater?*

Jake Joyce:

That is a difficult question because there are so many different environmental parameters that would factor into it, such as salinity, temperature, the amount of nutrients available, other microbial predation on the *E. coli*, different competition between the naturally occurring microorganisms, and so forth. I'm not sure whether that answer is available. Again, that is another area of open research because *E. coli* is a very important indicator of fecal pollution. Could they [*E. coli*] replicate with appropriate nutrients and temperature? I'm not certain. It seems that in warmer areas there is some indication of that occurring, as in tropical areas where the temperature is more consistent with that of the human body.

Q (Arnie Leder): This question is for Dr. Rose. You mentioned that you used tracers in the septic systems to identify plumes. Could you elaborate on that in terms of what was used for the tracer?

Joan Rose:

We used virus and bacteriophage tracers. We used the PRD1. It's a phage that is grown using a *Salmonella* host, and we don't find this particular phage in human sewage very often. We might find it once in a while, but it's very rare in terms of naturally occurring, compared with coliphage. We also used a vibriophage that was isolated in Hawaii and we had never found it in Florida waters. We had those two viruses. We grew them to about ten billion and injected them over an hour time frame, just flushing them once an hour down the toilet. Then we monitored for up to 5 days at about six stations throughout the canals in some monitoring wells that looked at some of the surficial ground water, as well as using a boat in the other areas, and took currents and other measurements.

Q (Nancy Hatfield, BioCheck Laboratory): My question is for Joan Rose. I wondered if you could say a little bit more about the pH-dependent desorption of Vibrio *from sediments?*

Joan Rose:

This is just some preliminary work that's been going on. Dr. Lipp, during her study of Charlotte Harbor, looked at sediment and water column for the fecal organisms and specifically for *Vibrio vulnificus*. In this case, she was able to start building a model based on salinity and temperature as to when you would see different concentrations of *Vibrio* in the water column, but it did not correlate with the concentrations seen in the sediments. She was also looking in the laboratory at adsorption coefficients, where she was taking marine sediments and looking at how much the bacteria adsorbed to the sediments. She found a desorption occurring at a certain pH. One of our hypotheses now (and this is something that needs further investigation) is that under these optimal temperature and salinity conditions vibrios desorb into the water column. We are not sure at beach sites how much might be found in sediments. That is an issue for swimmers who might have cuts on their feet acquiring vibrios. That is another area of investigation—the idea of the vibrios on the beach sites as opposed to out farther in the estuaries. They do have an optimal salinity, so if there is high salinity, you don't seem to find the vibrios as you would at moderate salinities. This is one of the things that we want to look at, but there were both laboratory studies and some studies in the field that suggested that in these conditions, the sediments acted as a reservoir and that there was partly a desorption and then a regrowth based on the optimal temperature and salinity.

Q (Holly Greening, Tampa Bay Estuary Program): This question is for Steve Schaub. I was interested in the real-time indicators, the dip-stick method. How viable are those considered and is this something that EPA will be approving in the short or long term?

Steve Schaub:

Al Dufour of the Office of Research and Development is in charge of the studies being conducted by EPA. They are looking at caffeine, detergents, and other chemicals as potential dip-stick indicators. There is a lot of research going on in this area. Nick Ashbolt and his associates over in Australia are looking at the fecal sterols, and they have some promising techniques if they can simplify them and make them more cost-effective. The fecal sterols are very good for discriminating various types of fecal sources/types. Right now, these tests are still in the laboratory phase, and obviously researchers are going to have to go out and test them in real-world waters, plus perform the collaborative testing, to make sure anybody can use them with a high degree of precision and accuracy. Then we will look at them from the standpoint of how practically they represent fecal contamination in epidemiological studies. Again, as Rick Hoffmann was alluding to earlier, we are probably a number of years from where we need to go in the process to have official methods for these dip-stick tests.

Q (Leslie Williams, State of Florida Department of Environmental Protection): This question is for the EPA representatives that we have here today. Will EPA be coming forth with a definition of beaches for us? The concern there is whether the indicator system, as proposed for bathing beach areas, will be specifically associated with our bathing beaches. Or whether they are anticipating that all of our Class III or recreational (fishable/swimmable) waters will include the new indicators?

Jake Joyce:

I'm from Region 7, and I'd still love to see some inland waterways because we have a lot of polluted swimming holes that people are in. It seems like a lot of the work so far has been done on both of the coasts with the large Atlantic cities, Miami beaches, the Santa Monica Bay, and the big coastal areas. I would personally like to see us start to move into freshwater because there is an awful lot of exposure that occurs in these bathing areas on small lakes and swimming holes where there are no sanitation devices and [waters] are shared with animals. There could be a lot of pathogen transfer. As far as I know, most of it has been geared toward the large beaches in the saltwater areas, not so much for the freshwater rivers, lakes, and ponds.

Q (Leslie Williams): The reason that this question comes up for us is that in order to be able to change the water quality criteria, we need to be able to determine whether the indicators, as proposed, are focusing on a designated bathing beach type area, and whether it is appropriate to use those indicator densities to apply to all of the fresh and marine waters that are recreational waters.

Steve Schaub:

I might expand on that a little bit. Currently, the criteria we have are for designated recreational sites where the local authority or the state has specifically defined them as a primary use beach. Also, we do have guidance which we are putting out for lesser used swimming areas or secondary recreational uses, such as for scuba diving, water skiing, and other contact uses where there is potential exposure. It is my understanding that Office of Water is coming out with improved guidance for secondary exposures in the near future that will have different allowable exposure criteria that will use the fecal indicators.

Matt Liebman:

Also, *Ambient Water Quality Criteria for Bacteria-1986* mentions a procedure for how to calculate the threshold values for less frequently used beaches based on measured variability from a site-specific case.

Q (Joanna Mott, Texas A&M University, Corpus Christi): I had a question about the E. coli *methods. If EPA came out with Method 1600 as the recommended method for the enterococcus, is there going to be one recommended method for* E. coli*? I know that there are a number of methods that are very similar but slightly modified from each other.*

Steve Schaub:

The current approach that EPA uses is that any methods for *E. coli* or enterococci have to be equivalent to the current *E. coli* or enterococci which the prescribed methods (1986 Criteria) currently measure. The reason is that when we developed the original analytical methods that were used in the epidemiology studies to characterize their association or relationship to acute gastrointestinal disease incidence, the ingredients of the media provided growth capabilities to the general strains of the two indicators that were considered representative of fecal contamination. Therefore, unless or until new epidemiological studies can be conducted on new candidate indicators, those that are to be considered as equivalent to the recognized methods must be demonstrated to detect and quantify the same indicator strains that were used to establish the epidemiological relationships, e.g., it is measuring the same organisms and therefore the same potential health risks. This of course requires that the methods go through the evaluation process for equivalency to insure that the precision, accuracy, and bias are statistically the same as the currently recognized methods.

Matt Liebman:

In New England, we've been getting a lot of calls about the use of the method called Enterolert®. Maybe that is one of the things you are asking about. As far as I know, headquarters is evaluating the use of Enterolert® for measuring enterococci under the procedures that Steve just talked about for inclusion in the Part 136 regulations.

Q (Dick Svenson, New York State Department of Health): I have a question for Steve Schaub. You mentioned waterfowl, bird droppings. I am particularly interested in small waterbodies, and you indicated that your studies showed increased levels due to their droppings. Have there been any studies on specific pathogens related to waterfowl and water quality?

Steve Schaub:

There are some specific pathogens of birds that are also pathogens of humans, for example strains of the *Salmonella* and *Shigella* group. Also, it has recently been recognized that birds may passively transfer human pathogens from environmental sources. For example, it has been shown that geese often feed on cattle manures and if the cattle are infected with *Cryptosporidium parvum* the manures are likely contaminated with high concentrations of the oocysts, although birds are not infected or diseased from these parasites. There does not appear to be a significant amount of degradation of the parasites in the bird's digestive tract. When the contaminated birds then fly to water to nest and defecate near to an area of human exposure such as a beach they can significantly contaminate the water as a typical goose can produce up to a pound of fecal material a day. I think that Dr. Ron Fayer at USDA's Agricultural Research Service Labs in Beltsville, Maryland has shown that *Cryptosporidium* oocysts are not significantly diminished in number or viability when passing through goose intestines. Thus there is pathogen transmission potential from infected avian species or indirect contamination from their feeding and nesting behaviors.

Q (Dick Svenson): I understand the potential. On the particular studies of huge amounts of waterfowl or birds on small waterbodies, have there been any studies where they have documented that occurring?

Steve Schaub:

By inference, maybe. I am not familiar with any specific studies directly relating bird populations to indicator levels but one might search the literature and find some. I think there have been studies that have shown that there is a loose association of coliforms and enterococci and high bird populations when there is no other obvious source of contamination. Again, I don't think there have been any direct measurements of waterfowl associated indicator levels in water. Indigenous animals like muskrats and beavers may also contribute fecal indicators to the water.

Comment (Rick Hoffmann, USEPA, Office of Science and Technology): I just wanted to comment on a couple of questions. One of the issues was the definition of "beaches." I think as EPA works on beach health issues, we are asked a somewhat different question than we were asked in the past. The ambient water quality standards, as most of you know, start with use designation of waters as either primary or secondary use waters. In other words, the state designated the particular use, and our criteria were designed as ambient water quality standards. They have typically been used to measure if you meet a standard when your dischargers are discharging into those waters. When we get into an issue of beach advisories or advice to people who are currently using the beach for recreational purposes, it raises a somewhat different issue. That is, you might use a geometric mean to characterize the overall, average water quality over a 30-day period. The question is whether that measurement is sufficient for the people who are out there swimming right now. In many cases it is not. That is why many states and localities are using a single sample maximum or some other thing that better characterizes their exposure. That is one of the things that we will try to address as we develop the guidance document—beach closures and openings and that sort of thing. It is somewhat of a different take than what has been addressed through the ambient water quality standards. We really didn't get into the definitions of "beaches" with ambient water quality standards because you simply designated all waters as to whether they are primary or secondary contact. So we did not have to get directly into an issue of what constitutes a beach. We started to get into that when we talked about a national beach survey, and we decided to accept whatever a county health department calls its own beaches. Will that issue come up in the guidance? It may be something that we need to talk about tomorrow as one of the issues that we need to address in subsequent guidance.

A final thing is that some of the new indicators that may come along may be sufficient to detect a presence or absence of fecal contamination. In other words, they may be used in a recreational beach. Whether they will be sufficient as a regulatory standard for dischargers or the designation of compliance with water quality standards is what Steve is starting to get into for the longer-term issues. They get fairly complicated.

Q (Joan Rose, University of South Florida): I've heard a number of states, in looking at the E. coli *standard, talking about changing their effluent discharges as well as their reclaimed water discharge standards. They say, "Well, this is good enough for swimming in. That means it's good enough for treating wastewater and putting it on food crops" and things like this. This really concerns me because that means that the fecal coliforms and the treatment itself will actually be lessened at the wastewater treatment plant. The disinfection step will be decreased, the efficacy of that particular process, and I am really concerned about the disconnect between the dischargers and the users at the endpoint there. I am wondering what kind of dialogue is going on at the federal level on these types of issues.*

Geoffrey Grubbs:

I agree that there is a need for dialogue between dischargers, pollution sources, and those who set standards. I am participating in an ongoing discussion primarily with city managers and people in politically elected positions to discuss this issue. How do you get out of additional control requirements for combined sewer overflows and for separate sewer overflow events? I also met with the state directors last week. They're concerned about the potential increase in costs associated with pollution control as well. They told me it's going to cost them a lot of money not only in terms of constituents but also for the time investment for their staffs to implement the changes. We need to be sure that we get the science correct first. After all, that's one of the main reasons for this conference. Then, and only then, should we address the consequences of pollution control.

Q (Mike Flannery, Pinellas County Health Department, Healthy Beaches Program): My wife was watching TV last night and saw that the temperature in San Diego in the water was 62 degrees. She noticed ours was dropping now to 82 degrees. We have done a lot of research at looking at E. coli *as an indicator. The kids that died in Japan got* E. coli *0157-87 from radish sprouts that were growing in the warm, humid climate. My question to you is do you think that lots of the information that EPA is using was developed in cold water areas? May it not be proper to have two separate standards, one for subtropical areas like Florida and maybe other ones for where you have breeding conditions and perhaps other environmental concerns?*

Geoffrey Grubbs:

The EPA studies performed on marine and fresh waters were located between Louisiana and New York and Ohio. So you can see that the studies represented a wide range of water temperatures. Earlier today, Thomas Mahin showed us a literature review of papers that span from the United Kingdom to Hong Kong. So, I think that the research is covering many conditions. However, both the EPA studies and those presented by Thomas Mahin were not performed under tropical and subtropical conditions. This leads us to the topic of two separate indicators for subtropical and temperate regions of the country. EPA is currently investigating the issue of tropical indicators. First, we have to determine if the organisms are reproducing under natural conditions. Then we can proceed to address separate standards. Keep in mind that the guidance document will allow for flexibility for states to use additional organisms based on their varying conditions.

Comment (Rick Hoffmann): Just one comment on that. You can raise those same questions this afternoon because Al Dufour and several other folks have been talking about the various studies.

Q (Robert Nobles, Florida State Health Office): You mentioned $20 million. When will the money be available? If available, how will the states be notified? Who is the contact person and how can the state of Florida be on the mailing list?

Geoffrey Grubbs:

Actually, we costed the implementation of the BEACH Program at $30 million. What we know right now is that the House has passed H.R. 999 and we are waiting for the Senate to act on either H.R. 999 or S. 522. The draft of the Senate bill does not have cost figures in it yet. The way the money will come is first by getting folks to agree that you need it, and we have reached that first step, agreement. The next step is to put it into a bill that authorizes the money, the President signs it, and we are hopeful for that next year. Then, in the appropriations process, the President requests and the Congress appropriates money that we then distribute/grant. The granting mechanism would primarily be the states. Remember, the money is available only if Congress passes the legislation. When that happens, EPA will have a major effort to notify states and localities through mailing lists and the regional offices of the availability of funds.

Session Two: Risk Assessment, Exposure, and Health Effects

The Relationship of Microbial Measurement of Beach Water Quality to Human Health

Al Dufour
US Environmental Protection Agency, National Exposure Research Laboratory

Please refer to page 39 in the West Coast Conference Proceedings.

Qualitative Review of Epidemiology Studies

Tom Mahin
Massachusetts Department of Environmental Protection

Please refer to David Gray's presentation on page 43 in the West Coast Conference Proceedings.

Epidemiologic Research on Bather Illness and Freshwater Microbial Contamination

Rebecca Calderon
US Environmental Protection Agency, National Health & Environmental Effects Research Laboratory

This presentation is an outline of some of the epidemiologic issues that have been identified over the last 15 years in the conduct of epidemiologic studies to evaluate water quality parameters that may be related to the occurrence of illness. Epidemic disease has long been recognized in this country. A review of the recreational outbreaks from 1991-1996 indicates that the majority of the outbreaks are of a parasitic etiology followed by bacterial. Surveillance for outbreaks is a passive system in this country, and the information collected represents only a fraction of outbreaks that occur. The health effects associated with swimming are gastrointestinal illness, eye and ear infections, upper respiratory illness, skin wounds, skin rashes and drowning. The focus of my talk will be on gastrointestinal illnesses.

In the last 15 years, studies have been done on every continent except South America. The majority of studies are evaluations of marine waters. In general, two types of epidemiologic study design have been used: cross-sectional and cohort. Both a prospective and a retrospective approach have been used in conducting cohort studies. Epidemiologic studies can be either observational (investigator does not control exposure to the risk factors) or experimental (investigator controls the degree of exposure). The advantage of observational studies is that they evaluate real world exposures under real world conditions and therefore are the exposures of interest. The disadvantage is that because there is no control by the investigator these studies can be subject to bias, especially bias due to exposure misclassification. The advantage of experimental studies is that because the investigator controls the parameters of the study the design can be more efficient (fewer subjects) and therefore more cost- efficient. Because the investigator controls exposure, there should be little if any exposure misclassification. The disadvantage of these studies is that like observational studies, they can be subject to confounding and it is often unknown if the exposures are the ones of interest. The issue becomes more confusing if a quasi experimental design is used. In these studies it is unclear whether the investigator is accurately measuring the exposure or has the degree of control as originally designed.

With gastrointestinal disease the focus of many studies, health effects have been assessed by reporting of symptoms either by interviewing or use of a daily diary. Some investigators have employed a physician-based diagnostic evaluation, and even fewer investigators have endeavored to collect and evaluate either stool specimens or serological specimens. Exposure assessment is usually some measure of water quality, generally a bacterial indicator. Recent studies have employed some measure of bather habits as part of their exposure assessment (e.g., duration in water, head wet). Another issue in conducting these studies is that many of the organisms that cause gastrointestinal illness can also be transmitted by other means (food, person-to-person, animal contact, foreign travel). It is very difficult with current methodologies to determine when an episode is related to food, contact with an infected person or recreational water exposure. That is why many studies take a population comparison approach. It is assumed that for any given population the other sources of organisms are the same for swimmers and non-swimmers. To date no studies have been done to validate or invalidate that assumption.

Bias and confounding are major sources of error that make it difficult to interpret epidemiologic studies. A major concern is non-differential bias of exposure classification. In most cases this random misclassification in both cases of disease and cases of non-disease generally tends to lower associations identified in studies. There have been cases where non-differential bias has artificially raised the association. In general, it is felt that because of the random nature of the error, the effect in studies of large associations (greater than relative risk of 3), is that non-differential bias has little impact. A major concern is differential bias, which is disproportionate exposure misclassification in either the diseased or non-disease population. This can have a substantial impact on the magnitude of the effect and the direction of the bias can be in either direction. This bias can also have substantial impact regardless of the magnitude of the relative risk. Another area of concern is the issue of confounding. Confounding occurs when a risk factor is associated with both the exposure of interest and the health effect. Typical confounders are age and socioeconomic class.

Another issue is the type of statistical analysis. The appropriate analysis is a function of the study design and the a priori hypotheses to be evaluated by the investigator. If the goal is to determine individual risk, analyses that are attempting to evaluate population risks may not be appropriate. The reverse is also true. When the goal is to assess a population's risk, a measure called the risk difference is more appropriately evaluated.

What will the next generation of new bathing beach studies look like? There have been advances in assessment of health effects through the collection of biological specimens, particularly blood for serological analysis. Also computer-assisted interviewing can be deployed, eliminating the effect an interviewer may have on the subject's responses. On the exposure side, a new generation of water quality indicators has been developed, and we understand bather behavior better and we can incorporate some determination of other sources of organisms into study designs to evaluate bias and confounding.

The research portfolio should be much broader with investigators employing a variety of different study designs. Given the increased knowledge today about other modes of transmission for the microbes of concern, that issue should be more aptly addressed in new studies. The important goal should be to conduct many studies of different study designs and look for congruence in the results. Hopefully as in the previous generation of studies, dose-response information can be obtained with less uncertainty.

EPIDEMIOLOGIC ISSUES IN BATHING BEACH STUDIES: PREPARING FOR THE NEXT GENERATION OF BEACH STUDIES

Rebecca L. Calderon, Ph.D., MPH
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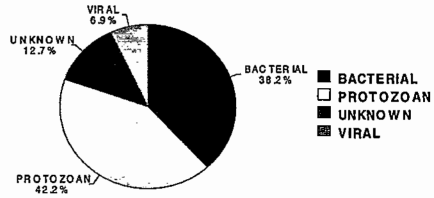
National Health & Environmental Effects Laboratory
US Environmental Protection Agency

WATERBORNE DISEASE OUTBREAKS 1991-1996



HEALTH EFFECTS

- Gastrointestinal disease
- Respiratory illnesses
- Ear and eye infections
- Skin wounds
- Skin rashes
- Drowning

REVIEW OF EXISTING STUDIES

[illegible]	Fresh	[illegible]
North America	[illegible]	[illegible]
South America	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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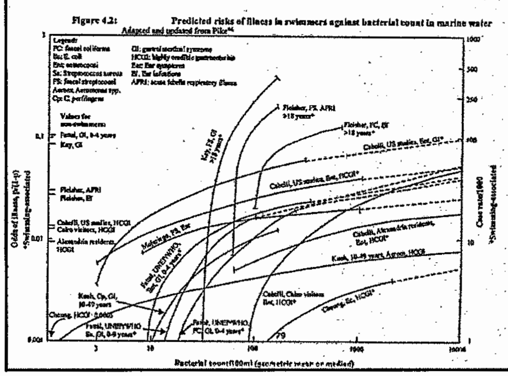


TYPES OF STUDIES

- Cross-sectional
- Case-control
- Cohort
  - Prospective
  - Retrospective

OBSERVATIONAL VS EXPERIMENTAL

Observational

Pros: Real World, Natural Variability, Right Exposures

Cons: Subject to bias and confounding, No control over exposure conditions

Experimental

Pros: Control the exposure conditions, More efficient

Cons: Artificial conditions, Subject to bias and confounding

QUASI EXPERIMENTAL

HEALTH EFFECTS ASSESSMENT

- Self report (Diary or interview)
- Medical confirmation
- Biological specimens
  - Blood
  - Stools

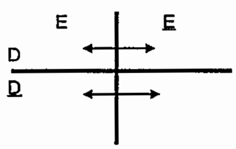
EXPOSURE ASSESSMENT

- Water Quality Measurement
- Bather Habits
  - Ingestion
  - Inhalation
  - Dermal Contact
  - Head Immersion
  - Duration

OTHER EXPOSURES OF INTEREST

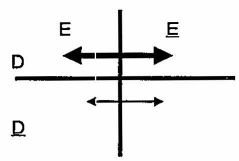
- Food
- Previous Illness
- Animals
- Young Children
- Travel (International)
- Ingestion of Untreated Water (Hiking)

BIAS



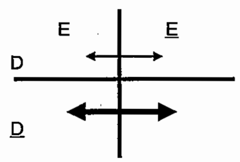
Nondifferential Exposure Misclassification

BIAS

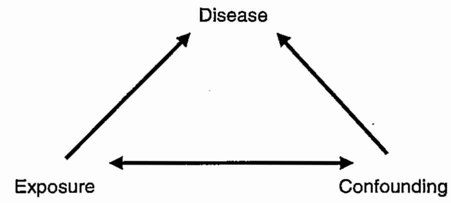


Differential Exposure Misclassification

BIAS



Differential Exposure Misclassification



CONFOUNDING

ANALYSIS OF DATA

Population versus Individual
- Objective of Study
- Study Design

Relative Risk versus Risk Difference

NEXT GENERATION HEALTH EFFECTS ASSESSMENT

Biological Specimens

Computer-Assisted Technology Interview

NEXT GENERATION EXPOSURE ASSESSMENT

Water Quality
Bather Behavior
Other Risk Factors

NEXT GENERATION STUDY DESIGNS

Observational
- Cohort

Experimental
- Cohort

Mixed Design
- Cohort

Question-and-Answer Session

Panel: Al Dufour, Tom Mahin, and Rebecca Calderon

Q (Richard Eskin, Maryland Department of the Environment): This session was very interesting; it was very helpful; it related to the factors that are important and compared the indicators. Accepting for the moment that enterococcus is indeed the best indicator, you have still not addressed how you set the threshold of that indicator and what level of potential risk that threshold is allowing. I'd like to hear more about that and what level of protection EPA thinks is appropriate and is assessing in setting the threshold for the indicator.

Al Dufour:

I believe that the Agency has made a judgment with regard to thresholds. For marine waters, that threshold is at 18 gastrointestinal illnesses per 1,000 swimmers. For freshwater, it is about 8 gastrointestinal illnesses per 1,000 swimmers. That judgment was made in 1986, and it was based on what was felt to be the acceptable risk at that time relative to all of the monitoring that had gone on before using the 200 fecal coliforms per 100 milliliter value. It was based on what is acceptable; there may be better ways of doing it, but that's the way that it was done.

Q (Richard Eskin): If a lot of information has accumulated since then, would EPA consider going back and saying, "Yes, the threshold we chose does still represent this threshold"?

Al Dufour:

It is my belief that if the beach plan is followed—if we develop better indicators, make better risk assessments, and do follow-up epidemiological studies—the Agency and everybody else will be able to make better judgments about "acceptable," or I like the word "tolerable" better. Acceptable means you sort of like it and accept it; tolerable means you don't like it but put up with it. In the future, I think that we will be able to come up with tolerable levels.

Tom Mahin:

If you look at the UK Beach Trial data, just a word of caution in applying this to other countries because if you look closely at that data, at the higher levels they had a greater illness rate than has been detected in studies in the U.S. Currently, the standard in marine waters is 104, and it raises questions about the daily maximum at that level, based on the UK Beach Trials, that those could be high illness rates. There is a lot of different data out there. We would recommend that EPA analyze the reasons for differences in illness rates relative to the daily maximum levels for marine waters.

Q (Barry Davis, National Park Service): I have spent about 20 years with the CDC and am fully familiar with the dilemma of epidemiological association of exposure and illness, particularly in bathing waters. It seems like we are in the same place we were in 20 years ago with being focused primarily on the easy part of the issue, which is the microbiological *indicators and the nuances thereof. I was glad to hear the presentations on the epi[demiology]. But I still don't see any plans for any good epidemiology, and my question is are there any epidemiology studies being planned and are there any funds available to implement those studies?*

Rebecca Calderon:
It is my understanding that in outlying budget years, starting in 2001, the plans are to conduct epidemiological studies. We are beginning to draw that information together, and I would anticipate that we will begin to conduct those studies either in 2002 or 2003. The question is how many will we be able to conduct and where will they be conducted? In the past, they have tried to be as geographically representative as they possibly could and to do an even amount between marine and freshwater. I believe that it is our intent this time around to do as many geographically representative samples of sites as we possibly can that meet some sort of criteria that we will develop in the next year or so. One of the things that will make an ideal site is a wide range of exposures. In other words, there will have to be a high probability over the course of the summer that you are going to have low and high days. I know, historically, a lot of places who think that they may be having high days are not interested in having you come along and do a study so you can tell the world, "Yes, we have high days," particularly if your results show that there were illnesses associated with that. There are social impacts associated with doing studies. My group has had bad luck, particularly in air pollution episodes. When we came to town to do a study, miraculously there was no pollution. So, please welcome us with open arms because your pollution might go away because we have come to town to do a study.

Tom Mahin:
From one state's perspective, we would love to see an epidemiological study based on a separate newly constructed separate sewer and drainage system so we knew that it wasn't being impacted by illicit connections. We would like to see the impacts of nonpoint source runoff, as EPA has done in Connecticut, to follow that up with a point source drainage system situation and also sample for pathogens (*Giardia* cysts, *Cryptosporidium*) and some PCR work on viruses. We could try to put that all together and resolve this urban storm water situation.

Q (John Barrett, Texas Coastal Coordination Council): The 1986 guidance document contained a promise from EPA that they would assess the effects of nonpoint source runoff on disease or enteric illnesses. Then, the study that has been referred to as the Connecticut study, that was published in 1991 as the answer to that question that was raised in the guidance document. There are some dramatic conclusions in that report from a manager's standpoint. There are some inconsistencies in the beach plan where it states that nothing is known today about animal impacts on illness. I am wondering if the two principal authors on the panel still feel that study is defensible.

Al Dufour:
When I reported on that study, I made it clear that it was a small study. I thought that the data were provocative and that there should be follow-up studies. I think that, for its size, the results were quite defendable. However, I have been saying for some time that follow-up studies are needed. Unfortunately, in 1992, the interest in wastewater studies increased (most of our bathing beach studies are associated with wastewater) and the budget went way down. Any hope to do a follow-up study disappeared. I think with the current EPA Beach Plan one of the key elements is to have a good method for determining what is human and what is animal pollution. I think that would describe point and nonpoint source

pollution. With those methods, when we get them, we will be able to do appropriate studies. Since I am from a laboratory, I don't want to make any promises for the Agency.

Q (John Barrett): We are making a lot of progress with the DNA and other methods in differentiating the sources. The question in my mind as the manager is what are we going to do once we have differentiated the sources? We find out that we have a bird problem, geese, as a contributor to fecal coliform in a stream. Is the 1991 study putting that stream on "kings x" or are you saying that we need additional studies along the same lines as the 1991 study to refine those questions?

Al Dufour:

That's what I was saying.

Q (Bob Nuzzi, Suffolk County, New York Department of Health Services): Given that the threshold levels were developed from the epidemiological studies and the vast majority of the epi[demiological] studies were performed in areas where there are and were point sources of pollution, do you think that it might be possible that those thresholds might be overly conservative for areas where we don't have those point sources of pollution?

Al Dufour and Rebecca Calderon:

Yes.

Q (Bob Nuzzi): As a manager and someone who is responsible for regulating bathing beaches, how can I cope with a standard that's being suggested or recommended that, in my case, would appear to have me closing more beaches for longer periods of time without any indication that there is any public health relationship to those closures?

Rebecca Calderon:

Remember your indicators are just one piece of information. The first speaker that we had this morning said that it needs to go hand in hand with things like a sanitary survey and other pieces of information. As a manager, I would be uncomfortable making a black-and-white decision based on indicator levels.

Comment (Bob Nuzzi): We never make those kinds of decisions based just on indicator levels. However, I would also like to indicate to you that there are people looking over our shoulders, in the public and environmental groups. We're in a very litigious society. If I come up with a number based on these standards that I should close this beach, I have a very hard time not doing so. So I think you have to consider what is being done here, in that if there is a standard being proposed based on information that's collected from areas where there are large point sources of pollution, I think we have to be very careful if we're going to utilize these same standards. If we're going to a federal standard that is going to be utilized in all areas, we have to take a lot of care with that.

Tom Mahin:

We do have to be careful because even if the studies show that pure storm water runoff doesn't pose the same health risk, at least where we are, the sewer systems are so old we see a lot of illicit connections in most storm drains. When it rains, you don't just get street runoff, you get sewage which is in the system that gets pushed out. We don't want the pendulum to go too far the other way and have something that says, "wet weather events are okay, so let's not remove illicit connections." This is a different standard. We think that there is a wet weather problem. The public health risk, we believe, comes from illicit connections, and that should be the focus. We believe that EPA's Phase II regulations should really focus on illicit connections also.

Comment (Bob Nuzzi): But those illicit connections are coming out of pipes. They are point sources.

Tom Mahin:

Absolutely. You just have to be careful on how the study is done because when you analyze pure storm water outfalls, to some people think that storm water outfalls are not a problem. But they are a problem when you have illicit connections.

Q (Dick Svenson, New York State Department of Health): We look at the indicators as a tool—as one of the factors that you consider before you open or close a beach. As a regulator, these numbers that were put together—35, 33, and 126—are rather precise. When you look at your charts, whether you are dealing with a log-log or a multi-log-log, and start plotting points and then pull them off for regulatory purposes, we can debate the threshold level. All things equal, how are you going to do it in the future to have some degree of tolerance knowing when you have small numbers and you're plotting them on those kinds of scales? These numbers obviously amazed me when they came out in 1986 compared to what we had before. It's just one more area to think about when you're looking at the numbers. I would like to have some feedback as far as when you do future epidemiological studies and plot them up and come up with another tool to discuss.

Al Dufour:

I believe, just as we are going to come up with new and better methods, new and better ways of doing epidemiological studies, hopefully, we will be very creative in how we set the limits. I think that there are new and better ways today that have been considered since 1986. And hopefully, we will use them. I think that most people don't understand how conservative the current indicator level is, and I think that at the time, in 1986, although we did have this data showing the relationship between indicators and health effects, there was a feeling that there was still a lot that the Agency did not know and, therefore, they went with the most conservative system available or that they could come up with.

Comment (Dick Svenson): This will explain some of the reluctance of the states to jump up from a regulatory standpoint to pick those kinds of numbers and have to go with them as far as the degree of tolerance. When we looked at them back in 1986 when they first came out, the obvious recommendation was what you are doing, which is doing more research and looking at them and fine tuning them. I think that is some of the difficulty when you look at defining, and this gets back to defining what are bathing waters and what is swimming. If the national goal is let's get it all there, then these are so important—to describe what's really bathing waters as far as if you are going to use this as one of the criteria.

Al Dufour:

I'm sure the Agency understands that problem. I hope I can speak for the Office of Water. One of the reasons for these conferences is that they want to get input from the states and cooperation from the states so that the limits that are chosen, first of all, make sense, and secondly, so that everybody buys into the system.

Q (Deana Levengood, Tampa Bay Estuary Program, League of Women Voters): As a member of the public, we're glad that you're having this forum and that you've invited us *to participate because it's kind of nice to know what you're grappling with. We are educated in our process through the estuary program, but the general public as a whole doesn't really know what a lot of these issues are about. A couple of questions from the public's perspective might be, as I recognize, is that as managers, you have to develop your criteria and do your best effort to protect the masses, but I think that a lot of information is not passed through the public and that the public can assist in helping to make informed decisions in that regard—what's important to them and what's not—especially with community groups that are looking at these kinds of issues. Particularly in light of our area here dealing with wet seasons or wet weather events. We have a lot of them here in Florida. In this area, in fact, they contribute a great deal to a lot of our issues and we have some of our normal sewage challenges. We have the overflows at times of very wet weather because we don't have the best places for injection wells and because of our water supply being so close to the surface and contaminated a lot. What's happening now, with regard to some of the hurricane opportunities, and I'll say that they are challenges, but they are also opportunities, in light of looking up in the Carolinas, what's been happening there with the animal waste and the other things. Are there any studies in place or being planned so you can capture some of the data that might be available, taking water quality sample information at this time and seeing what kind of epidemiological impacts it may have in the future, what kind of health impacts, and then trying to tie them together? It seems to me that when we have these crisis types of situations, we have to be prepared to go in and do some massive sampling all at one time and I don't know if that is practical or effective. We may be able to learn something from it by having it happen all at one time and in a large dose.*

Rebecca Calderon:

Since I am from North Carolina, I'll answer the question. In terms of what the Agency is doing, I believe that particularly in Region 4, [the Agency] is working with the state of North Carolina to look at some of the impacts on the beach areas, particularly in terms of flooding in the freshwater rivers and the delta where the freshwater rivers run into the marine environment. It would be very difficult to do a recreational study in North Carolina now because it's past the recreational season and a lot of the beach areas, because of the hurricane, no longer have access to them because of the flooding or a lot of people just have packed it up and gone home for the season. We are in the process of our third hurricane in the last 2 months, and I think that a lot of people are going to pack it in for this year. In terms of an opportunity there to do recreational studies, probably not. Given the random nature of hurricanes, I would be very reluctant to plan a recreation-related type of epidemiology study based on hurricanes. It would just be really difficult to do. But there could be a lot of things that could be learned, at least from a microbiological standpoint.

Q (Deana Levengood): Maybe I should clarify something. I'm not talking about recreational studies. I'm talking about when people are displaced or they're flooded, people are exposed to coastal waters. Maybe not recreational, but there are people wading around being exposed to those waters and in some cases having to swim through those waters to get through different areas. And that is an opportunity, again, to do sampling for different kinds of exposure.

Rebecca Calderon:

I'll tell you what the state of North Carolina told us: "You tell me what's more important, getting people back into livable housing or running around collecting health information from individuals who may or may not be ill." It's just a matter of public health priorities when emergencies like this happen. And they actually got annoyed with the Office of Research and Development because they were more interested in us providing crews to help with the clean-up efforts than they were in having us come down and do those kinds of health studies. So, while it's an interesting idea, I think that you have to look at where the priorities are when something like that comes to town. And it's probably not in whether or not Joe Blow out there running around in his little skiff is going to get diarrhea because he fell in the water. It's difficult to look at that. Now, one of the things that we are interested in is the impact that this flooding is going to have on ground water supplies. Ground water is a major source of water in eastern North Carolina, and that is something we are working with the state to look at over the long haul.

Comment (Jennifer Wigal, USEPA, Water Quality Standards Branch): There is a point that I want to revisit and perhaps make a couple of clarifications regarding the risk levels associated with the 1986 criteria. I want to reiterate that those criteria levels, as Al mentioned earlier, are for application on a conservative nationwide basis. Those are also to be used in conjunction with a designated use setting, when the states set their goals for the waterbody. These are the criteria we feel are appropriate to protect those designated uses and also to assess the long-term health of a waterbody and whether or not it is meeting that use over the long term. For beach opening and beach closing situations, I think that perhaps there is a lot more flexibility than is being perceived by some of the states as to how they do a day-to-day open-and-closing decision. This is our recommendation on a national basis for what we feel is probably at this time the most appropriate way to protect those waterbodies over the long term.

Tom Mahin:

We do have a lot of problems with people trying to interpret the mean, geometric mean, and daily maximum, and some people sample once every 2 weeks and some sample once a week. It seems very unclear to us when to apply the 200 and when to apply the 400, so I would hope that in the future, that, if there are any changes, the system is simplified because there are a lot of different beaches out there and there are all kinds of different sampling frequencies.

Q (Gary White, Macomb County Health Department): The question that I have is regarding sampling techniques, such as the depth of the water the samples are collected in and depth below the surface and things like that. Have any of those issues been looked at in any of the studies that have been done, or are there any plans to look at how best to measure exposure through varying sample techniques and what not?

Rebecca Calderon:

The UK study looked at three depths: there was the knee depth, there was the chest height, and I forget what the third one was. And the chest height in their studies turned out to be the best one. Since I was one of these people who literally waded out into the water, we did ours at about between 3 and 4½ feet in terms of where we collected the water on the beach. Part of the problem in beach studies is that you have these tidal actions and I remember, particularly in the Boston area, having to walk quite a ways to some point at low tide to get out there where it was at least up to my knees in the water. I think that in the next round of studies that may possibly be a component in terms of what's a more appropriate measure of exposure.

Comment (Gary White): I think that would be a very important thing to look into.

Session Three: Monitoring and Modeling

Indiana's *Escherichia coli* Task Force

Arnold Leder
US Environmental Protection Agency, Region 5

Beaches at the Indiana Dunes National Lake Shore and the State Park in northwestern Indiana usually close several times each year during the summer swimming season due to *E. coli* contamination. *E. coli* is an indicator organism which indicates the presence of fecal material in the water. For the past year, USEPA, USGS, National Park Service, Indiana DNR, Indiana Department of Environmental Management, Indiana Department of Public Health, numerous county and local agencies, and universities have been working together in an effort to identify the sources of the *E. coli* discharges which are responsible for closing the beaches. Areas being looked at include not only direct dischargers with NPDES permits, but also Combined Sewer Overflows, failing septic systems, contributions from concentrated animal feeding operations, improperly land applied sewage sludge, marine vessel contributions and even contributions from wildlife. In addition to the research aspects of this task force, IDEM and USEPA are working in partnership to maintain an especially effective compliance and enforcement presence in the watershed to ensure that all point source dischargers comply with NPDES permit requirements.

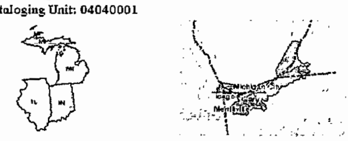
Northwest Indiana *E. coli* Task Force Accomplishments 1999: Beach closures at Northwest Indiana beaches, monitored by the National Park Service, experienced an increase in 1999 (23) over 1998 (12). While 10 of 12 beach closures last year were associated with Combined Sewer Overflows (CSO), this swimming season was generally dryer without the major storm events after July, suggesting that other factors play a part in the problem as well. In spite of the increases in beach closings, the following successes were achieved by the multi-agency task force:.

- Continued the efforts of the voluntary monitoring network and completed a report of last year's results. The report identifies Combined Sewer Overflows as a major contributor to beach closings.
- IDEM and USEPA continued enforcement and compliance assistance efforts in the watershed, with special attention paid to minor dischargers.
- Non-Point Source Committee initiated stream surveys to identify failed septic systems and subsequent actions by state and local health departments.
- The Indiana Dunes State Park (Indiana DNR) began a sewer system evaluation and is doing intensive monitoring of tributaries within the park. Dunes Creek runs through the park and regularly exceeds coliform standards at its mouth. Dunes Creek divides the State Park beach into an east and west beach. This year the State Park took steps to restrict access to Dunes Creek through the use of signage and cones.
- Indiana University and USGS conducted monitoring during three major storm events at Burns Ditch in an effort to determine *E. coli* loadings to Lake Michigan and area beaches.
- USGS conducted trials of a new flow cytometer which measures *E. coli* cells in order to study whether it will provide a more rapid indication of when the beaches should be closed.
- Indiana Geological Survey completed the Derby Ditch Study in an effort to determine beach closing predictors. The results of the Derby Ditch Study can be accessed from the Lake Rim Web Site at http://129.79.145.25/indmaps/ims/lakerimmo/lakerim_front.html.

- During the course of the year citizen groups became more involved and press coverage and public awareness of the problem increased.
- At the request of the *E. coli* Task Force, the Great Lakes Commission will hold a workshop on marine sanitation devices later this fall.

Northwest Indiana *E. coli* Task Force

Little Calumet-Galien
USGS Cataloging Unit: 04040001

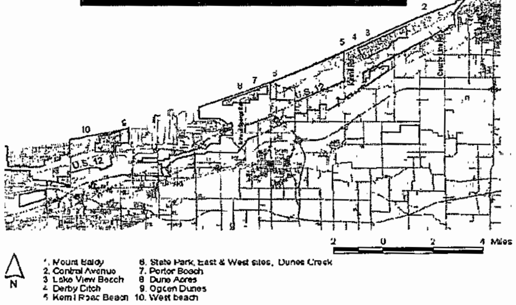


Arnold Leder
US Environmental Protection Agency, Region 5

E. coli Task Force

- Officially formed in 1995, at the suggestion of commercial interests in northwest Indiana who came to a number of state and federal agencies and asked for assistance in solving the coliform contamination problems at Indiana's Lake Michigan beaches.

[redacted]



Beaches affected include:

- Indiana Dunes National Lake Shore
- Indiana Dunes State Park
- Municipal beaches

The watershed includes:

- The northern half of Lake, Porter and LaPorte counties in northwestern Indiana
- Includes the Grand Calumet and Little Calumet River systems, Trail Creek, portions of the Saint Joseph River, Derby Ditch and Dunes Creek.

The watershed (cont):

- Home to one of the world's largest concentration of steel manufacturing
- Rapid growth in the southern portion of the watershed ahead of municipal sewer systems
- Because of the parks and beaches, tourism in northwest Indiana is also a major industry.

Sources of Contamination:

- Combined Sewer Overflows
- Failed septic systems
- Agricultural inputs from land-applied manure
- Major and minor point source discharges
- Marine discharges
- Storm water

Potential Sources (cont):

- Wildlife
- Infrastructure at park facilities (sewer systems, pump outs and privies)

History:

- Prior to the Clean Water Act, many beaches in the area were routinely closed
- Treatment plant expansion led to reopening many beaches in the late 70's and early 80's
- Over the past decade, the rivers, creeks, and ditches of northwest Indiana have exceeded state criteria for swimmable waters (< 235 *E. coli* per 100 ml H_2O).

Member Agencies:

- US and Indiana Geological Surveys
- Indiana and Purdue Universities (Sea Grant Program)
- National Park Service
- Indiana Department of Natural Resources
- Indiana Department of Health
- Indiana Department of Environmental Management

Member Agencies (cont)

- USEPA
- County health departments from Lake, Porter and La Porte Counties
- Representative from local municipalities' wastewater treatment plants
- Industry representatives
- Natural Resources Conservation Service (USDA)

Completed projects:

- USEPA and IDEM, in 1997, completed CSO Inspections at all major municipalities with CSOs in the watershed.
- For the past 4 years, IDEM and USEPA have focused compliance inspections in the watershed, with particular attention being paid to minor dischargers which have resulted in state and federal enforcement actions.

Task Forces:

- Nonpoint Source
- Point Source Task Force
- Monitoring
- Marine

Point Source Task Force:

- In the fall of 1997 began monitoring at 80 different locations in the watershed.
- Worked with the municipalities and health agencies and the Park Service in order to ensure that each agency has implemented approved methods for *E. coli* sampling and analysis.

Standardized *E. coli* Monitoring

Standardized Operating Procedures for Recreational Water Collection and Analysis of *E. coli* on Streams, Rivers, Lakes, and Wastewater

Cooperative Efforts

- An example of the cooperation being achieved by the task force can be found in the case of Oak Tree Mobile Home Park.
- Although this facility only discharges 60,000 gallons per day, the treatment plant had failed and the load being discharged was equal to what a complying 3 million gallon per day plant would be discharging.

Cooperative Efforts (cont)

- The company, under federal enforcement, was ordered to come into compliance with NPDES permit requirements.
- In order to solve this problem, the City of Portage allowed the mobile home park to install a pump station and force main in order to eliminate their discharge.

Cooperative Efforts (cont)

- The owners have agreed to fund research in the area as part of a supplemental environmental project.

Point Source Task Force

- Has established a voluntary monitoring network at 80 locations throughout the water shed.
- Voluntary participants in this project include the three county health departments, major municipalities and the National Park Service and several major industries.

Point Source Task Force (cont)

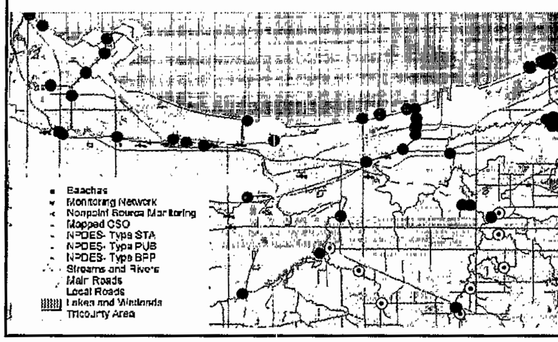
- Samples are taken each Wednesday at the interior sites and each Thursday at the beaches.
- The results of this monitoring will assist officials in isolating sources of *E. coli* throughout the watershed.

Northwest Indiana Beach Closings

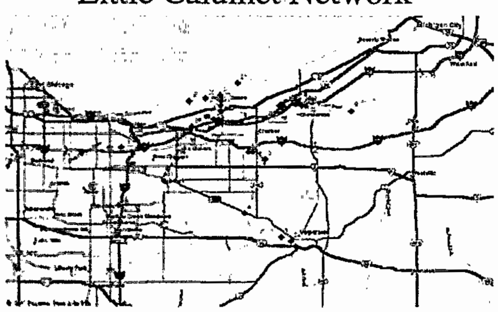
Memorial Day through Labor Day

Year	Closings
1999	24
1998	12
1997	18
1996	10
1995	10

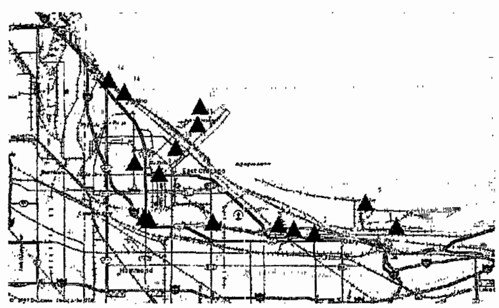
Fixed & Nonpoint Monitoring



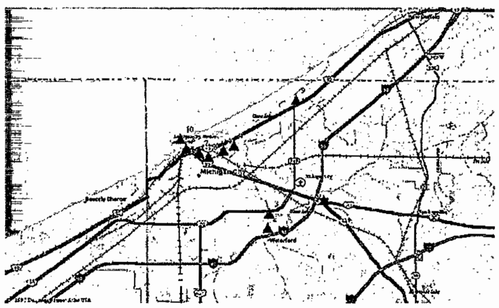
Little Calumet Network



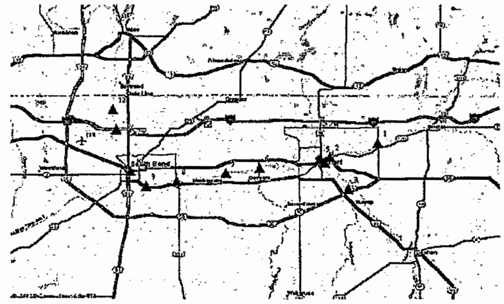
Grand Calumet Network



Trail Creek Network



St. Joseph Network



FY99 Accomplishments

- IDEM and USEPA continued enforcement and compliance assistance efforts in the watershed with special attention paid to minor dischargers.
- Continued the efforts of the voluntary monitoring network and completed a report of last years results. The report identifies Combined Sewer Overflows as a major contributor to beach closings.

FY99 Accomplishments (cont)

- Non-Point Source Committee initiated stream surveys to identify failed septic systems and subsequent actions by State and local health Departments.
- The Indiana Dunes State Park (Indiana DNR) began a sewer system evaluation and is doing intensive monitoring of tributaries within the park.

FY99 Accomplishments (cont)

- Indiana University and USGS conducted monitoring during 3 major storm events at Burns Ditch in an effort to determine *E. coli* loadings to Lake Michigan and area beaches.
- USGS Conducted trials of new flow cytometer which measures *E. coli* cells in order to study whether it will provide a more rapid indication of when the beaches should be closed.

FY99 Accomplishments (cont)

- Indiana Geological Survey completed the Derby Ditch Study in an effort to determine beach closing predictors.
- At the request of the *E. coli* Task Force, the Great Lakes Commission will be holding a workshop on marine sanitation devices later this fall.

Clean Water Compliance Watch

Or Where We Go From Here

- OECA's fiscal year 2000 EMPACT Project intends to focus on development and implementation of its hazard assessment tool in northwest Indiana watersheds.
- The hazard assessment tool, is a system that combines baseline information, monitoring data, and modeled results to estimate conditions prevailing in the watershed at any time.

Predictive Modeling of Bacterial Indicators Along the South Shore of Lake Pontchartrain

Jeffrey Waters
Lake Pontchartrain Basin Foundation

A.J. Englande, Jr.[1], Henry B. Bradford [2], Mike Schaub[3]
[1] Tulane University, Department of Environmental Health Sciences, School of Public Health & Tropical Medicine, [2] Louisiana Department of Health and Hospitals, Division of Laboratories, Office of Public Health, [3] US Environmental Protection Agency, Region 6

The south shore of Lake Pontchartrain has for years been polluted to such an extent that swimming and other recreational activities have been prohibited. The metropolitan New Orleans area lies mostly below sea level and is completely encircled by flood control levees. Storm water runoff is collected in a system of drainage canals and pumped into Lake Pontchartrain as a flood control mechanism. Water quality problems in Lake Pontchartrain are directly related to pumped storm water runoff, and state health officials have declared that swimming is not advisable within ¼ mile of the south shore due to bacterial contamination. However, over the last several years, there has been an effort to revitalize the lake and recent water quality sampling suggests that conditions have improved along the south shore. The purpose of this project is to characterize the movement of certain bacterial indicators in runoff from drainage and to develop a predictive model to assist state and local health officials in determining when and where primary contact recreation activities may be pursued in Lake Pontchartrain. The specific objectives of the project include:

- Define microbiologically the dimensions of the water "plume" that is being discharged into the lake for a given rainfall event.
- Determine the titers of certain microorganisms within the plume of pollution and the titer reduction rate of these organisms in the initial area of observation.
- Define the movement patterns of microbes.
- Develop a model that will allow the accurate prediction of indicators and infectious organisms that would migrate away from the original plume area.
- Use this model as a tool to open the lake for primary contact recreation activities at least in specific areas.

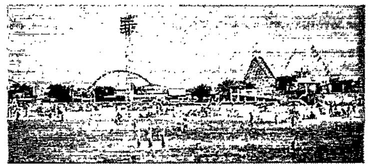
To determine what factors may influence the fate of indicator organisms, an integrated rainfall/runoff-oriented lake water sampling design was effected. The indicator organisms studied are *E. coli*, the enterococci group, and fecal coliform. Additionally, physicochemical parameters and environmental data are recorded to facilitate the development of a model that may produce reasonable projections on the movement and fate of these organisms and their titers. Physicochemical parameters monitored include dissolved oxygen (DO), pH, turbidity, salinity, conductivity, Secchi disk transparency, and temperature. Environmental data collected include wind speed and direction, rainfall amount and intensity, current direction and velocity, and pumpage volume and rate. The overall purpose of the project is to characterize the distribution of certain indicator microorganisms in the urban runoff into Lake Pontchartrain based on sampling events. A deterministic model incorporating biotic and abiotic parameters, hydraulic and rainfall information, and GIS mapping is being developed to evaluate the distribution and fate of pertinent microorganism indicators. A neural-network model is also being developed that will allow for predictions of lake water quality based on physicochemical parameters.

The project was recently enhanced through the procurement of a grant from the US Environmental Protection Agency EMPACT (Environmental Monitoring for Public Access and Community Tracking) program. With funds from the grant, the Lake Pontchartrain Basin Foundation (LPBF) and the US Geological Survey-Water Resources Division (USGS/WRD) have installed a continuous multiprobe recorder at Lincoln Beach on the south shore of Lake Pontchartrain. The multiprobe recorder measures DO, pH, salinity, conductivity, and turbidity and is equipped with a satellite uplink so that continuous monitoring data is available and posted on the LPBF and USGS/WRD web sites. Because the predictive model links bacterial indicators to physicochemical parameters, the availability of continuous, real-time monitoring data through instant access to the multiprobe recorder will allow continuous assessment of water quality conditions at Lincoln Beach.

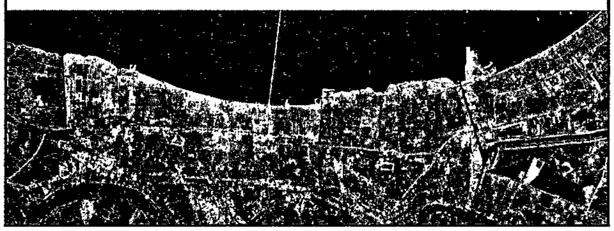
Predictive Modeling of Bacterial Indicators Along the South Shore of Lake Pontchartrain, Louisiana

- Jeff Waters, Lake Pontchartrain Basin Foundation
- A.J. Englande, PhD, Tulane University School of Public Health and Tropical Medicine
- Henry Bradford, PhD, Office of Public Health, Louisiana Department of Health & Hospitals
- Mike Schaub, USEPA, Region Six

Pontchartrain Beach Circa 1950



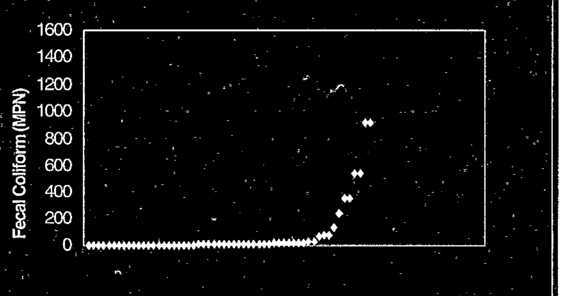
South Shore Lake Pontchartrain



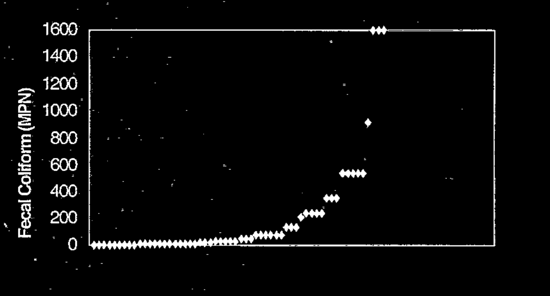
Lake Pontchartrain Basin Foundation Volunteer Water Quality Testing Program

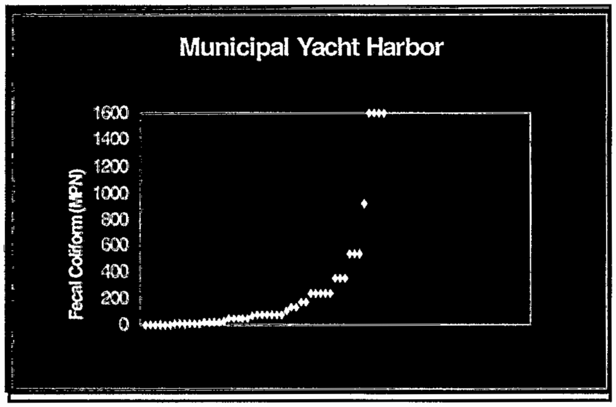
- 17 Sampling Locations on South Shore
- Samples Collected by New Orleans Power Squadron
- Analyzed for Fecal Coliform by LaDHH
- Period of Record: January 1994 to Present

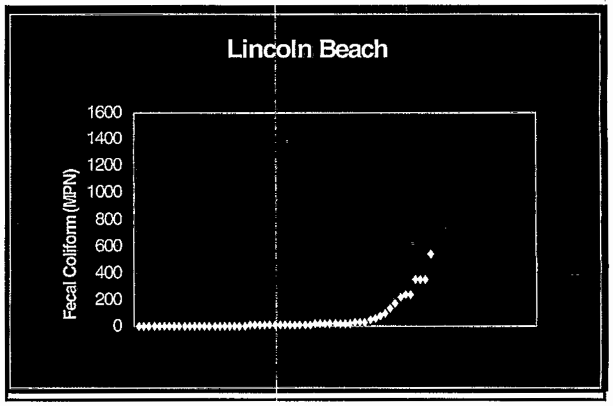
Duncan



Bonnabel Offshore







Project Goals

- Characterize the distribution of certain indicator microorganisms in urban runoff to Lake Pontchartrain.
- Develop a deterministic model to understand the distribution and fate of pertinent indicator organisms.
- Develop a predictive model that will assist state and local health officials to determine when and where primary contact recreation activities can be pursued in the lake.

Three Phase Approach

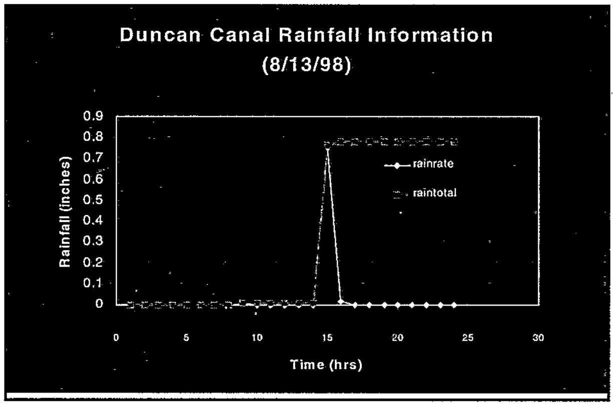
- Phase I – Characterization and Model Development
- Phase II – Continued Model Development and Lincoln Beach Characterization
- Phase III – Model Validation

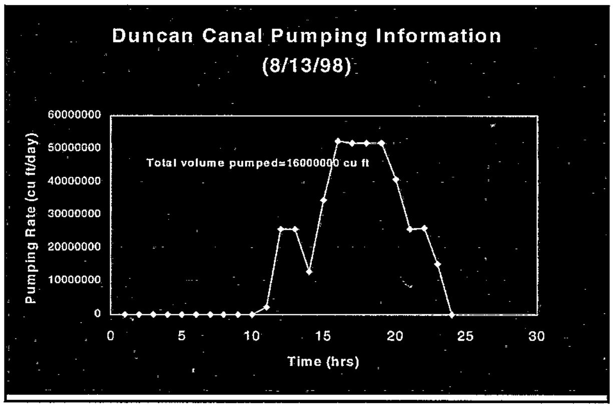
Phase I – Model Development

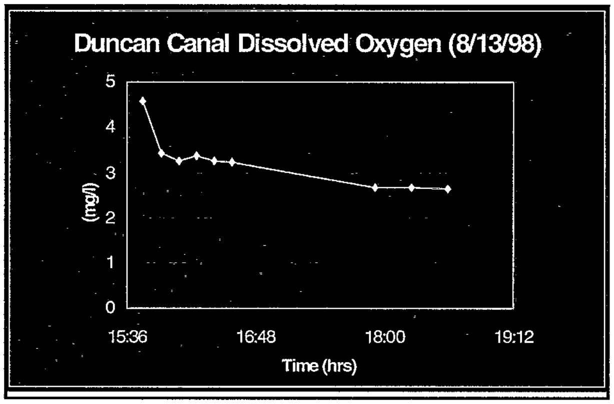
- Stormwater Characterization
- ARGOS Buoy Deployment
- Grid Sampling

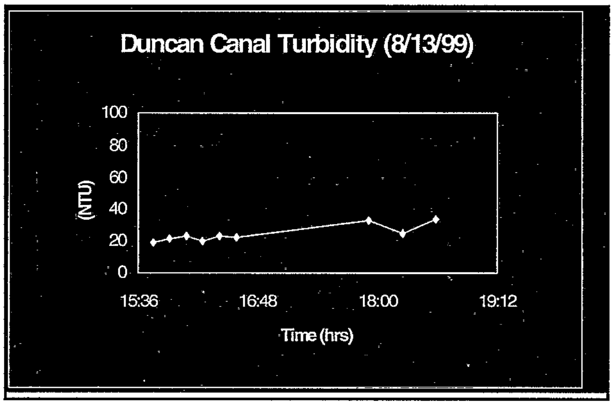
Phase I – Parameters Measured

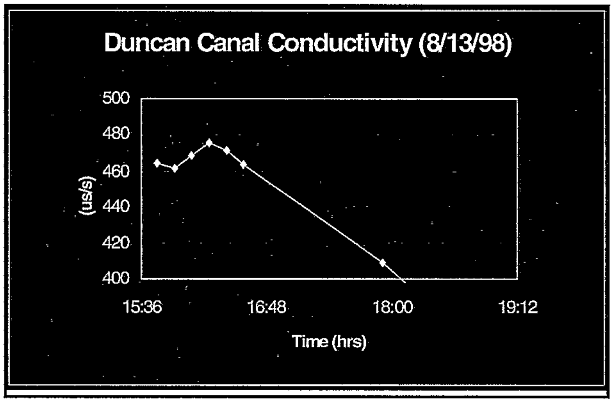
- Rainfall
- Discharge Volume
- Current Speed/direction
- Wind Speed/direction
- Fecal Coliform
- E coli
- Enterococci
- pH
- DO
- Conductivity
- Turbidity
- Secchi Disk Transpency
- Air/water Temperature

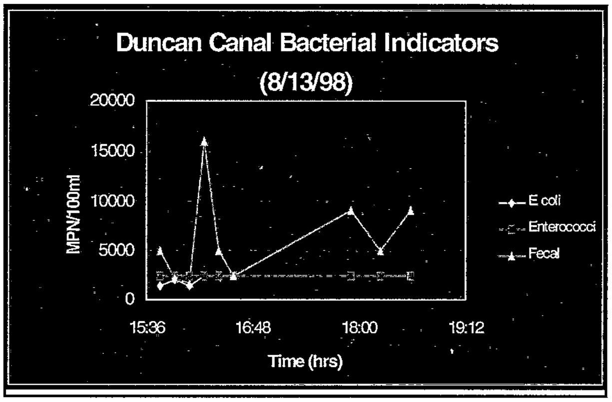

Duncan Canal Rainfall Information
(8/13/98)
Rainfall (inches)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
rainrate
raintotal
0
5
10
15
20
25
30
Time (hrs)

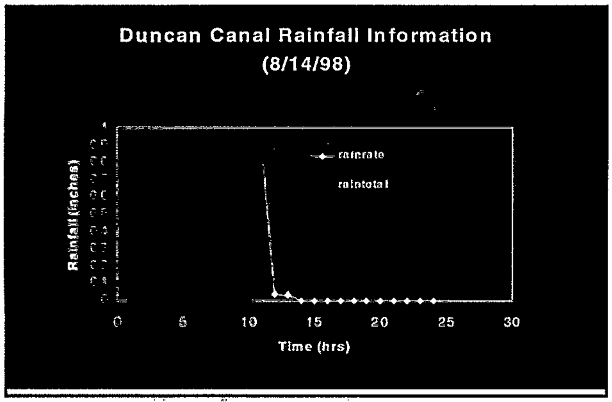

Duncan Canal Pumping Information
(8/13/98)
Pumping Rate (cu ft/day)
60000000
50000000
40000000
30000000
20000000
10000000
0
Total volume pumped=16000000 cu ft
0
5
10
15
20
25
30
Time (hrs)

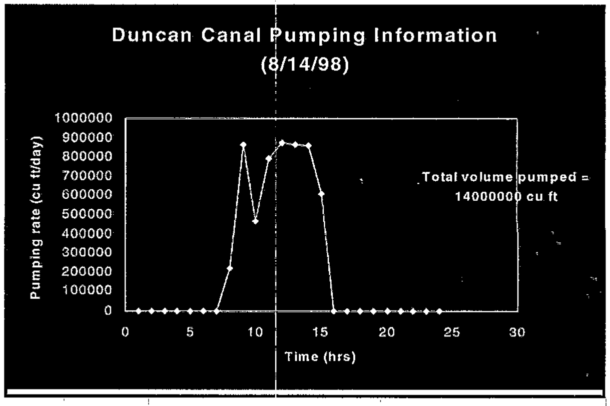

Duncan Canal Dissolved Oxygen (8/13/98)
(mg/l)
5
4
3
2
1
0
15:36
16:48
18:00
19:12
Time (hrs)

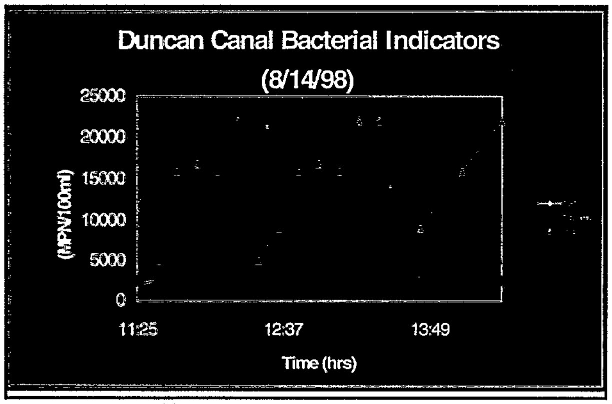

Duncan Canal Turbidity (8/13/99)
(NTU)
100
80
60
40
20
0
15:36
16:48
18:00
19:12
Time (hrs)

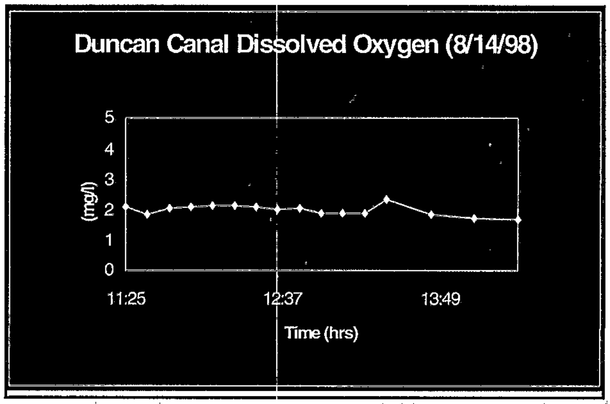

Duncan Canal Conductivity (8/13/98)
(us/s)
500
480
460
440
420
400
15:36
16:48
18:00
19:12
Time (hrs)

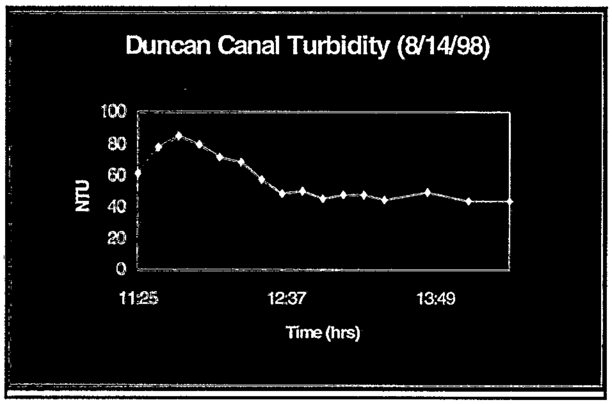

Duncan Canal Bacterial Indicators
(8/13/98)
MPN/100ml
20000
15000
10000
5000
0
E coli
Enterococci
Fecal
15:36
16:48
18:00
19:12
Time (hrs)

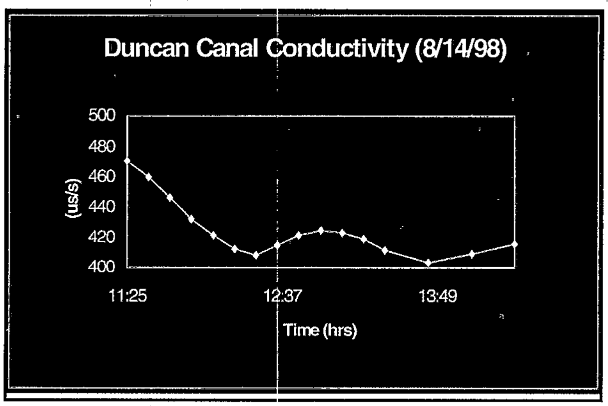

Duncan Canal Rainfall Information
(8/14/98)
Rainfall (inches)
raintotal
0
5
10
15
20
25
30
Time (hrs)

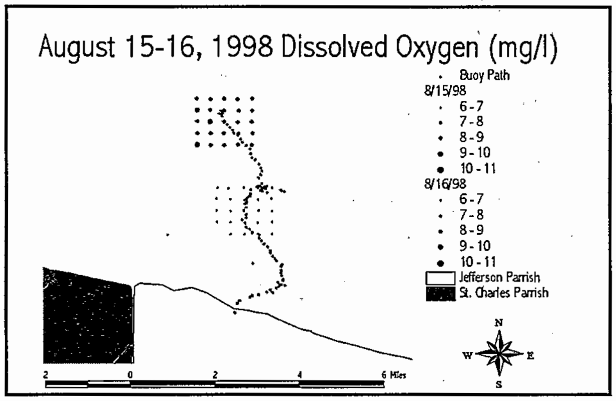

Duncan Canal Pumping Information
(8/14/98)
Pumping rate (cu ft/day)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
Total volume pumped =
14000000 cu ft
0
5
10
15
20
25
30
Time (hrs)

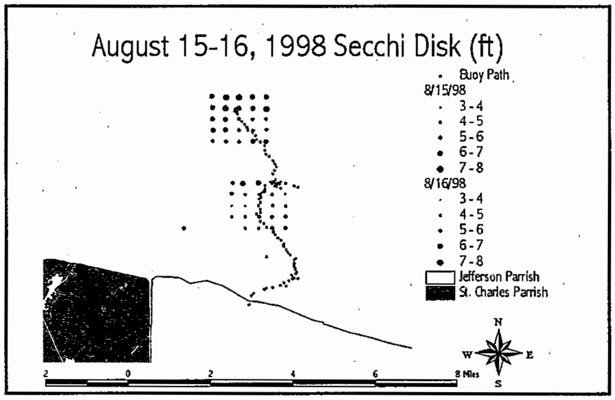

Duncan Canal Bacterial Indicators
(8/14/98)
(MPN/100ml)
25000
20000
15000
10000
5000
0
11:25
12:37
13:49
Time (hrs)

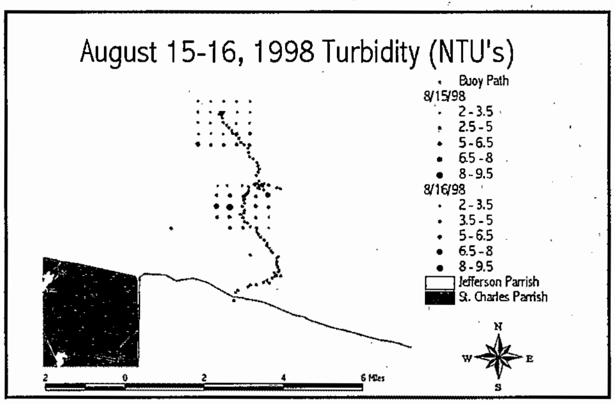

Duncan Canal Dissolved Oxygen (8/14/98)
(mg/l)
5
4
3
2
1
0
11:25
12:37
13:49
Time (hrs)

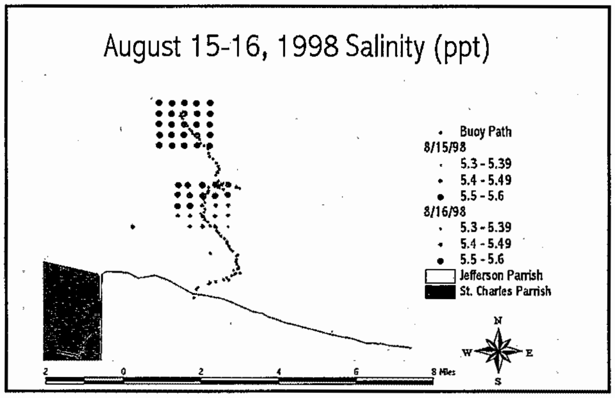

Duncan Canal Turbidity (8/14/98)
NTU
100
80
60
40
20
0
11:25
12:37
13:49
Time (hrs)

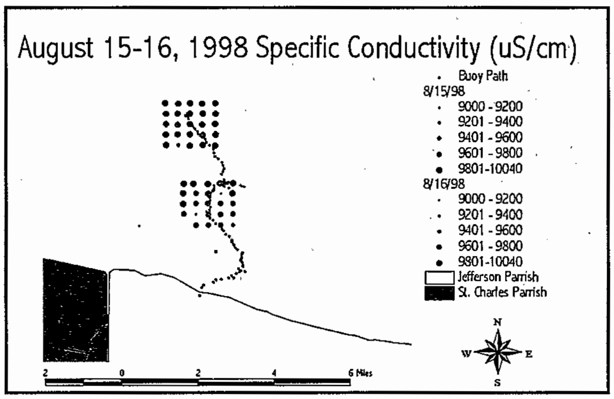

Duncan Canal Conductivity (8/14/98)
(us/s)
500
480
460
440
420
400
11:25
12:37
13:49
Time (hrs)

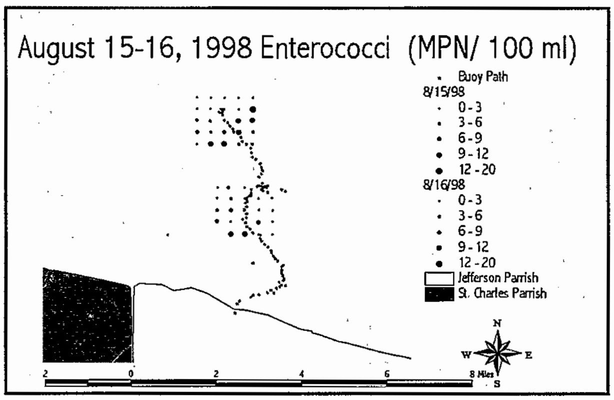

August 15-16, 1998 Dissolved Oxygen (mg/l)
Buoy Path
8/15/98
6-7
7-8
8-9
9-10
10-11
8/16/98
6-7
7-8
8-9
9-10
10-11
Jefferson Parrish
St. Charles Parrish


August 15-16, 1998 Secchi Disk (ft)
Buoy Path
8/15/98
3-4
4-5
5-6
6-7
7-8
8/16/98
3-4
4-5
5-6
6-7
7-8
Jefferson Parrish
St. Charles Parrish

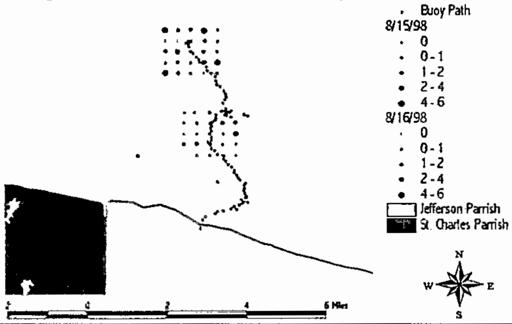

August 15-16, 1998 Turbidity (NTU's)
Buoy Path
8/15/98
2-3.5
2.5-5
5-6.5
6.5-8
8-9.5
8/16/98
2-3.5
3.5-5
5-6.5
6.5-8
8-9.5
Jefferson Parrish
St. Charles Parrish


August 15-16, 1998 Salinity (ppt)
Buoy Path
8/15/98
5.3-5.39
5.4-5.49
5.5-5.6
8/16/98
5.3-5.39
5.4-5.49
5.5-5.6
Jefferson Parrish
St. Charles Parrish

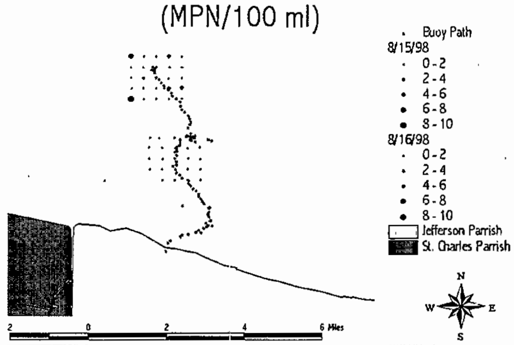

August 15-16, 1998 Specific Conductivity (uS/cm)
Buoy Path
8/15/98
9000-9200
9201-9400
9401-9600
9601-9800
9801-10040
8/16/98
9000-9200
9201-9400
9401-9600
9601-9800
9801-10040
Jefferson Parrish
St. Charles Parrish


August 15-16, 1998 Enterococci (MPN/ 100 ml)
Buoy Path
8/15/98
0-3
3-6
6-9
9-12
12-20
8/16/98
0-3
3-6
6-9
9-12
12-20
Jefferson Parrish
St. Charles Parrish

August 15-16, 1998 E. Coli (MPN/ 100 ml)



August 15-16, 1998 Fecal Coliform (MPN/100 ml)



Phase II

- Continue Development of Deterministic Model
- Characterization of Lincoln Beach Water Quality

Deterministic Model

- Statistical Relationship Between Indicator Organisms and Physicochemical Parameters
- Deterministic Near Field Model – Steady State Model
- Deterministic Far Field Model – Time Variable Model

Lincoln Beach Water Quality

- 12 Stations sampled five times/month (June – October, 1998)
- Fecal Coliform – Log Mean Range: 2 to 5 MPN/100 ml
- Enterococci - Log Mean Range: 2 to 7 MPN/100 ml
- E coli - Log Mean Range: 1 to 3 MPN/100 ml

Phase III

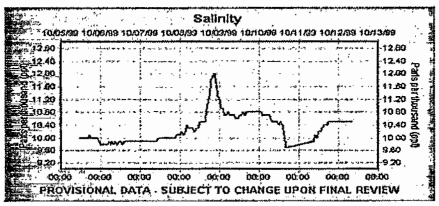
- Validate Deterministic Model
- Develop Predictive Model

Environmental Monitoring for Public Access and Community Tracking (EMPACT)

- Continuous Real-Time Multiprobe Recorder
- Satellite Uplinked
- Available at www.saveourlake.org or www.ldlabrg.er.usgs.gov

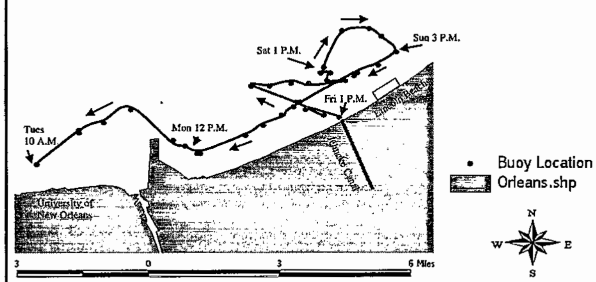
Multiprobe Recorder

Lincoln Beach Water Quality Data

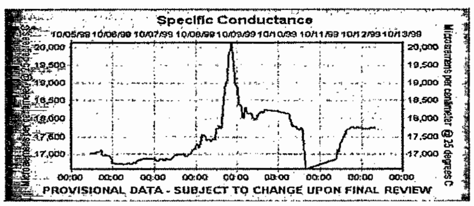


October 99 Drifter Buoy Event

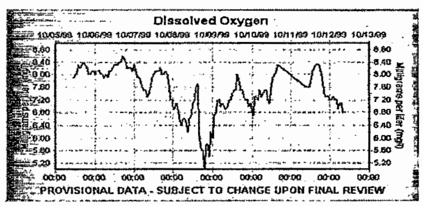
[Friday 08 – Tuesday 12]



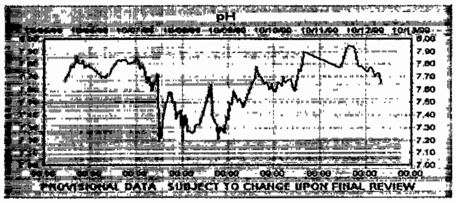
Lincoln Beach Water Quality Data



Lincoln Beach Water Quality Data



Lincoln Beach Water Quality Data



Status and Future Goals

- December 1999- Deterministic Model Validated
- December 1999 – Predictive Model Complete
- June 2000 – Louisiana Department of Health & Hospitals initiates monitoring program at Lincoln Beach
- June 2001 – Louisiana Department of Health & Hospitals "reopens" Lincoln Beach to swimming using Predictive Model and multiprobe recorder to provide daily status

A Regional Modeling Tool for Impacts of Spills and Bypasses

Phil Heckler
New York City Department of Environmental Protection

A Regional Bypass Group, formed in July 1997, was composed of representatives from various governmental agencies concerned with unplanned/planned bypasses of raw sewage to receiving waters which may impact bathing areas and/or shellfish beds. At the time, there were no formal procedures to inform the various entities of a bypass and there were no readily available tools to quickly assess whether action measures should be taken. Existing measures at the time could include enhanced monitoring of a potentially impacted area and the possibility of temporarily closing a bathing or shellfish area. Therefore, the Regional Bypass Group was committed to develop methodologies to quickly assess the impact of a bypass and to develop procedures to communicate the occurrence of an event.

Beginning in September 1997, a Modeling Analysis subgroup met periodically to develop a predictive tool for use by Administrators. Our consultants, Hydroqual, provided technical insight throughout the process to develop a model that could quickly assess the severity of a discharge. The basic premise for the modeling effort was that a methodology would be developed to determine the impact on beaches and shellfish beds of a bacterial discharge due to a raw sewage bypass. Three types of output were generated—graphical, tabular, and a computer program (Regional Bypassing Program). Since the graphical and tabular outputs are quite voluminous, the Regional Bypassing Program is by far the easiest to use. The program is a menu-driven, user-friendly tool which displays maps locating discharge and receptor sites. The user specifies some basic information of the discharge (volume, concentration and water temperature) and the program interpolates archived model output to these conditions. The user can view which areas are impacted by the discharge and then can tabulate or graph receiving water responses at the various receptor sites. Within minutes, therefore, the user can quickly assess the severity of a discharge and if it will impact a beach or shellfish bed. This information then helps decision-making authorities formulate an action (or no action) plan.

The program was completed in May 1998 and has been used successfully for the last two summers. This predictive model has helped prevent the unnecessary closure of beaches in several cases. In one or two instances it has been used proactively by Health Department officials to close a beach during the time period during which the beach would be impacted by a raw sewage bypass.

NY-NJ Harbor Wastewater Bypass Model

Phil Heckler
NYC Dept of Environmental Protection

Beach conference

Background

- Harbor-wide water quality improvements
  - all NYC public beaches reopened
  - wet weather advisory lifted or relaxed
- Planned shutdown sensitizes region (Jan 97)
- Unrelated pump station failures (June 97)
  - pipeline leak & station shutdown
  - both disinfected within hours

Widely Varying Response

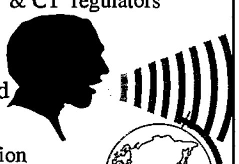
- First event (pipeline leak)
  - NYC closes adjacent beach, one day
  - Westchester closes 26 beaches up to week
- Second event (station shutdown)
  - NYC closes nearby embayment beaches one day
  - Westchester closes distant open water beaches
    - remain closed up to five days
  - CT closes beaches for extended period
  - Helicopters track " sewage slicks"

What caused the widely varying response?

- Lack of communication
- Media hype
- Algae slicks and wet weather slicks
- No acceptable predictive tool
- Weekend boat activity not previously measured

Communication Begins

- July 1997 meeting in Tarrytown, NY
  - attendees (~30) include NY & CT regulators and dischargers and ISC
  - frank discussions
- Subcommittees established
  - modeling analysis
  - communication & notification



Bypass Modeling Subgroup

- Expanded to include EPA and NJ
- Goal established:
  - develop a predictive model to reduce unnecessary precautionary closures
  - gain acceptance by regulators and local health and sanitation authorities

Participants

- Wastewater
  - NYS DEC
  - NJ DEP
  - CT DEP
  - ISC
  - EPA
  - NYC DEP
- Consultant
  - HydroQual, Inc.
- Shellfish & Health
  - NYS DEC
  - NYS DOH
  - NJ DEP
  - FDA
  - Nassau Co DOH
  - West. Co DOH
  - NYC DOH

Model Considerations

- Parameter of concern: bacteria (total and fecal coliform, enterococcus)
- Water bodies:
  - NY-NJ Harbor
  - LIS & Atlantic Ocean
- Variables:
  - wind, temperature, hydrodynamics
  - duration, quantity & quality of discharge

Approach

- Use Mathematical Model
  - System-Wide Eutrophication Model (Hydroqual)
  - Apply Coliform Kinetics
  - Calculate Unit Load - Responses
    - Select Discharge Locations (29)
    - Select Receptor Site Locations (53)
    - Specify Seasonal Temperatures (3)

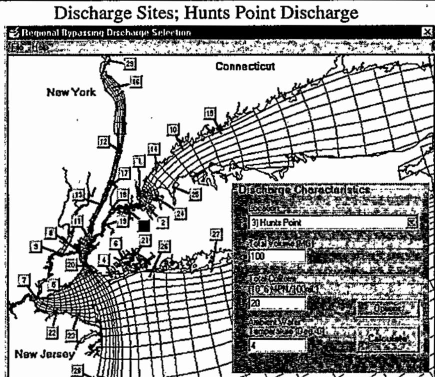
Types of Model Output

- Graphical
  - Temporal Profiles
    - > 2500 Profiles
  - Spatial Profiles
    - > 1000 Profiles
- Tabular
    - > 250 Tables
- Computer Program

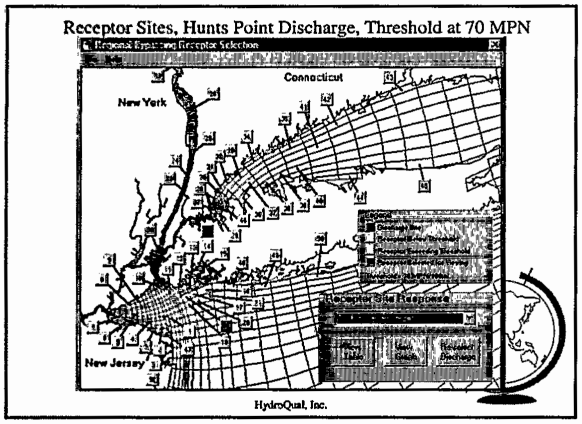
Regional Bypass Program

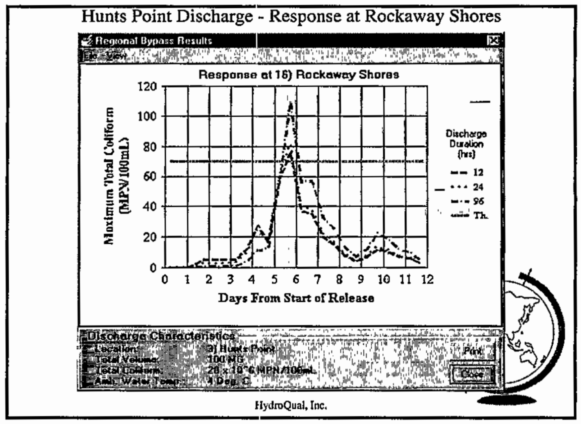
- Discharge Characterization(input)
  - Select Discharge Location
  - Volume (MG)
  - Concentration
  - Water Temperature
- View Results(output)
  - Choose Threshold Conc. (Optional)
    - View area-wide results
  - Select Receptor Site Location
    - View Temporal Profile

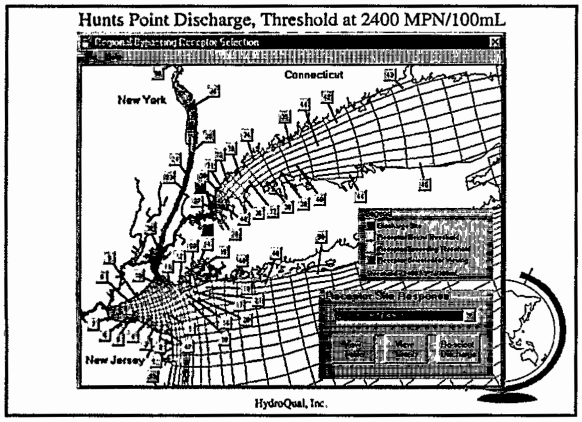
Discharge Sites; Hunts Point Discharge

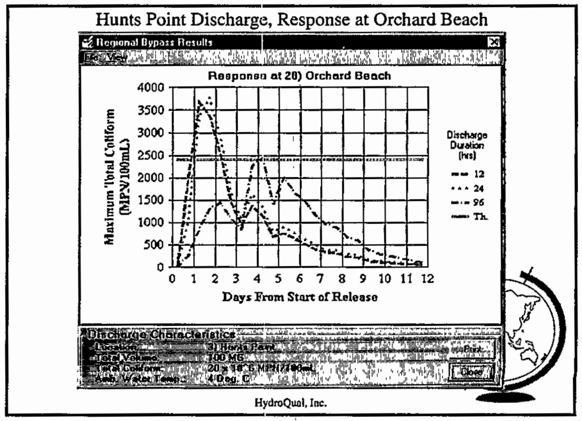


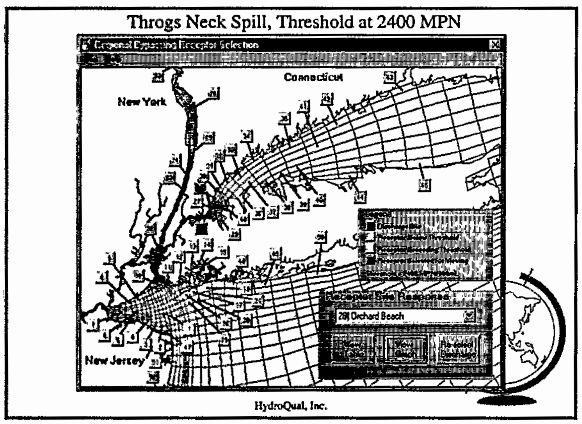
HydroQual, Inc.

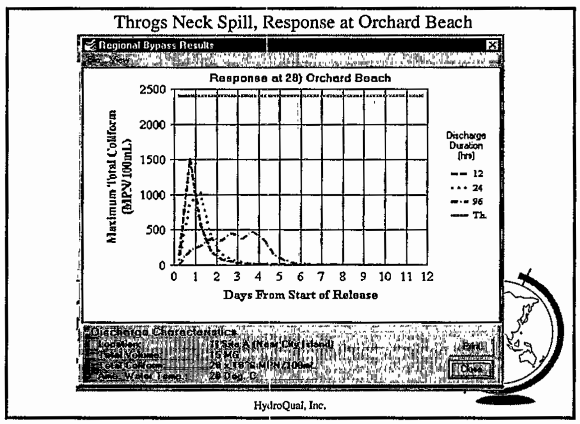

Receptor Sites, Hunts Point Discharge, Threshold at 70 MPN
Connecticut
New York
New Jersey
Receptor Site Response
HydroQual, Inc.


Hunts Point Discharge - Response at Rockaway Shores
Regional Bypass Results
Response at 18) Rockaway Shores
Maximum Total Coliform (MPN/100mL)
Days From Start of Release
Discharge Duration (hrs)
12
24
96
Th.
Discharge Characteristics
HydroQual, Inc.

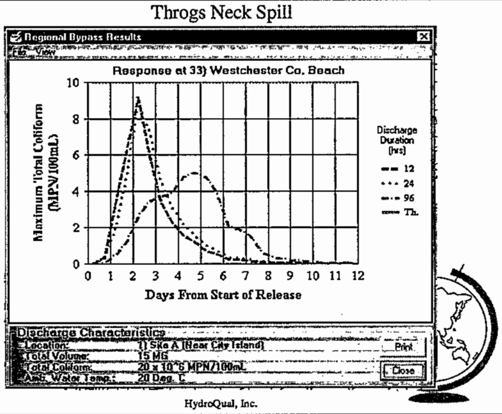

Hunts Point Discharge, Threshold at 2400 MPN/100mL
Connecticut
New York
New Jersey
Receptor Site Response
HydroQual, Inc.


Hunts Point Discharge, Response at Orchard Beach
Regional Bypass Results
Response at 28) Orchard Beach
Maximum Total Coliform (MPN/100mL)
Days From Start of Release
Discharge Duration (hrs)
12
24
96
Th.
Discharge Characteristics
HydroQual, Inc.


Throgs Neck Spill, Threshold at 2400 MPN
Connecticut
New York
New Jersey
Receptor Site Response
28) Orchard Beach
HydroQual, Inc.

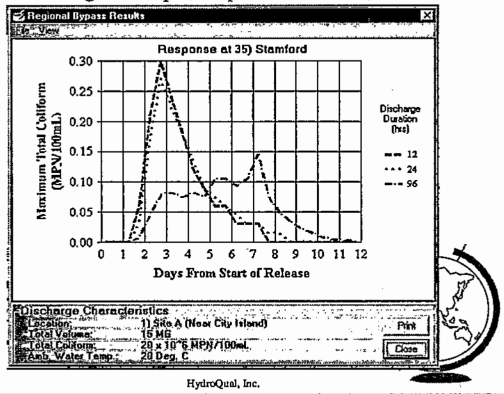

Throgs Neck Spill, Response at Orchard Beach
Regional Bypass Results
Response at 28) Orchard Beach
Maximum Total Coliform (MPN/100mL)
Days From Start of Release
Discharge Duration (hrs)
12
24
96
Th.
Discharge Characteristics
HydroQual, Inc.

Throgs Neck Spill



HydroQual, Inc.

Throgs Neck Spill, Response at Stamford, CT



HydroQual, Inc.

Observations

- The June 1997 Westchester, Connecticut, Beach Closures Would Not Have Occurred With Regional Bypass Program
- The Program Was Used Successfully
  - 1998 New Rochelle &Yonkers
  - 1999 various
  - No Unnecessary Beach Closures

Finally

- The Collective Efforts of Many Tristate Agencies Are Acknowledged
  - Immensely Improved Communications
  - Developed a Predictive Tool to Evaluate Impacts of Spills and Bypasses

New Jersey's Recreational Monitoring Program

David Rosenblatt
New Jersey Department of Environmental Protection

Please refer to page 59 in the West Coast Conference Proceedings.

Question-and-Answer Session

Panel: Arnold Leder, Jeff Waters, Phil Heckler, and David Rosenblatt

No questions were asked.

Great Lakes Monitoring Program

Paul Horvatin
US Environmental Protection Agency, Great Lakes Program Office

The Great Lakes comprise 20 percent of the surface freshwater in the world. Another 20 percent is locked up in the ice caps. More than 33 million people live in the Great Lakes states, which have approximately10,000 miles of shoreline. Great Lakes states report more than 571 beaches with an additional 200 in Canada, totaling over 770 beaches in this region.

SOLEC, State of the Lakes Ecosystem Conferences, produces a biennial report to meet the goals of the Great Lakes Water Quality Agreement. The process is science-based, comprising over 20 teams who assess and report the condition of the Great Lakes. The teams assess the physical, chemical, and biological issues related to the Great Lakes. The teams take this information and process it to try to achieve the desired outcomes—fishable, swimmable, and drinkable. They look at the Great Lakes region by geographic zones—offshore, nearshore, and coastal wetlands and terrestrial. They also address nongeographic issues such as human health, land use, and stewardship.

The process for SOLEC indicators involves establishing a core group and panel of experts to mine existing documents for indicators. They are to select, revise, combine, and create indicators. At the end of the process they will propose a suite of indicators. The process also involves stakeholders who help revise the indicators. Including the stakeholder process builds consensus, collaboration, and cooperation. For example, SOLEC may identify fecal pollution levels of nearshore recreational waters as important to the International Joint Committee (IJC) desired outcome of swimmability. The indicators would be frequency of beach closings at specific locations and counts of fecal coliforms and/or *E. coli* in recreational waters. To examine the swimmability, the indicators would be beach closings as median number of consecutive days closed for a given year and coliform counts, turbidity, phosphorus concentrations, aesthetics, and beach characteristics.

Currently, fecal coliform and *E. coli* are being investigated. Fecal pollution levels of nearshore recreational waters in Canada are monitored using *E. coli*. The IJC has been collecting data since 1981 and they have found that out of the 571 beaches, one-third currently measure and close beaches using *E. coli*, 28 percent use total and fecal coliform, and 29 percent are not monitoring at all. They've also learned that they need to close beaches after storm events.

Most of the beaches (88 percent) were open for the entire swimming season, from Memorial Day to Labor Day. Half the beaches are monitored on a regular basis, but 2 percent are monitored only when there is a complaint. The remaining 48 percent are not monitored at all. The overall goal of the program is to keep 'em great.

Selecting Great Lakes Indicators: The United States and Canada Experience

Paul J. Horvatin
U.S. EPA
Great Lakes National Program Office
Beaches Conference

What is SOLEC?

- State of the Lakes Ecosystem Conference
- Biennial report on progress toward meeting goals of the Great Lakes Water Quality Agreement
- Science-based, consultative process to assess and report the condition of the Great Lakes

Organizing Frameworks

- Science Disciplines
  (Physical, Chemical, Biological)
- Desired Outcomes (IJC)
  (Fishability, Swimmability, Drinkability....)
- Geographic Zones and Nongeographic Issues
  (Offshore, Nearshore, Coastal Wetlands, Nearshore Terrestrial, Human Health, Land Use, Stewardship)

Process for SOLEC Indicators

- Establish Core Groups & Panels of Experts
- Mine Existing Documents for Indicators
- Select, Revise, Combine, Create Indicators
- Propose Suite of Indicators
- *Involve Stakeholders* (Review, Revise, Review, Revise, Review, Revise...)
- Build Consensus, Collaboration, Cooperation

Great Lakes Beach Quality Indicator

SOLEC:

Fecal Pollution Levels of Nearshore Recreational Waters

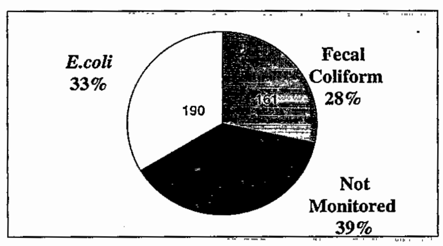
- Frequency of beach closings at specific locations
- Counts of fecal coliforms and /or *E. coli* in recreational waters

IJC:

Swimmability

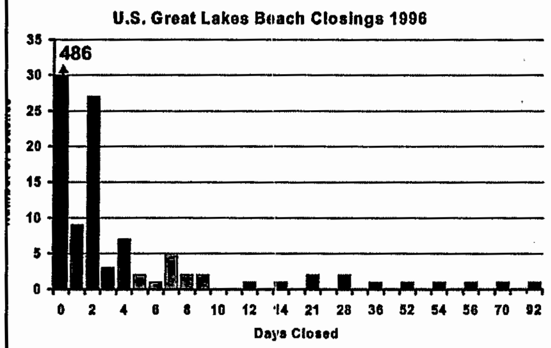
- Beach closings as median number of consecutive days closed for a given year
- Coliform count, turbidity, phosphorus conc., aesthetics, beach characteristics

General Criteria for Beach Closing



Monitoring Practice VS Percent of Season Open 1996

Percent of season open	Monitored on a regular basis	Monitored on complaint	Not monitored	Totals
100	203	73	210	486
95-99	41	3	2	46
90-94	12	-	-	12
<90	10	-	1	11
Totals	276	76	213	555



Factors Affecting *Escherichia coli* Concentrations at Lake Erie Public Bathing Beaches

Donna Francy
US Geological Survey, Ohio District

The environmental and water quality factors that affect concentrations of *Escherichia coli* (*E. coli*) in water and sediment were investigated at three public bathing beaches in the Cleveland, Ohio, metropolitan area. This study was done to aid in the determination of safe recreational use and to help water resource managers assess more quickly and accurately the degradation of recreational water quality. Water and lake-bottom sediments were collected and ancillary environmental data were compiled for 41 days from May through September 1997. Turbidity, antecedent rainfall, volumes of wastewater treatment plant overflows and metered outfalls, a resuspension index, and wave heights were found to be statistically related to *E. coli* concentrations; however, wind speed, wind direction, water temperature, and the presence of swimmers were shown to be statistically unrelated. Multiple linear regression (MLR) was used to develop a model to predict *E. coli* concentrations at the three beaches. The chosen MLR model used weighted categorical rainfall, turbidity, and wave height to predict *E. coli* concentrations. This model accounted for 58 percent of the variability in *E. coli* concentrations. For 1997 it predicted the recreational water quality as well as and in some cases better than the current method.

For more information, please refer to: Francy, D.S., and R.A. Darner. 1998. *Factors Affecting* Echerichia coli *Concentrations at Lake Erie Public Bathing Beaches.* U.S. Geological Survey Water-Resources Investigations Report 98-4241.

Factors affecting *Escherichia coli* concentrations at Lake Erie public bathing beaches

Water-Resources Investigations
Report 98-4241
by D.S. Francy and R.A. Darner

In cooperation with

- Ohio Water Development Authority
- Northeast Ohio Regional Sewer District
- Ohio Lake Erie Office
- Cuyahoga County Board of Health
- Cuyahoga County Sanitary Engineers
- Cuyahoga River Community Planning Organization

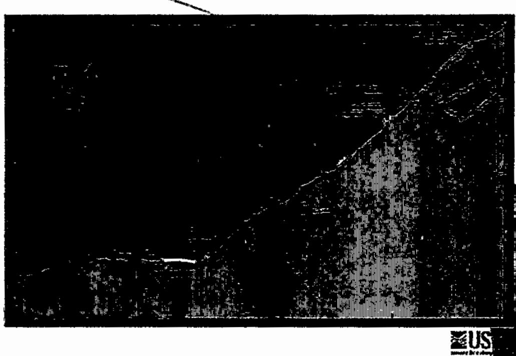
Problem

- Water quality advisories
- Current methods to determine water quality take 24 hours to complete
- Factors that affect *E. coli* concentrations are not well understood
  - -Resuspension of bacteria from sediments

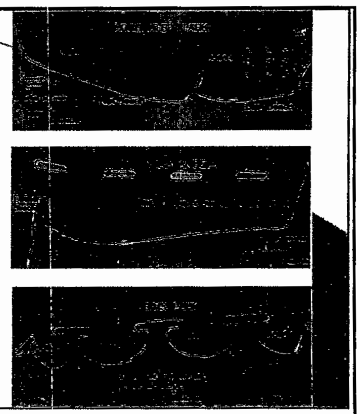
Objectives

- What environmental and water quality factors are related to *E. coli* concentrations?
- Can *E. coli* concentrations be predicted accurately from other factors?
- How do sediment-stored bacteria affect water quality?

Study area

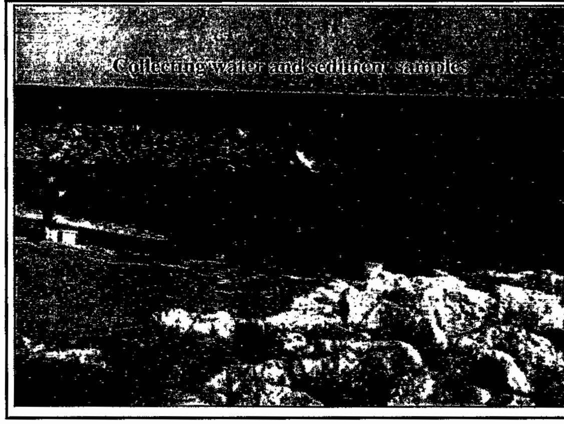


Sampling areas

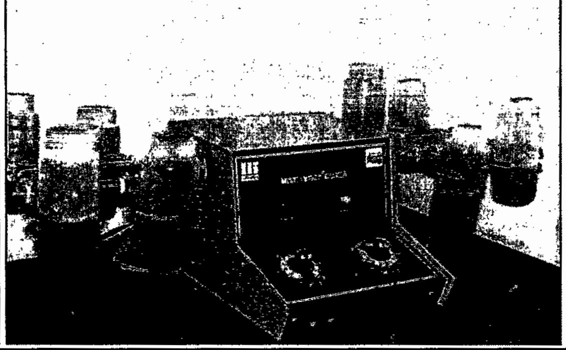


Sampling Frequency

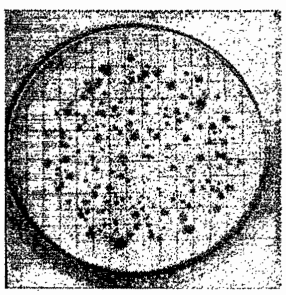
- Eight field studies
- 41 sampling days
- May through September 1997
- Sampling from 6 to 9 a.m.
- 10 days also included an afternoon sampling



Removing bacteria from sediment



Escherichia coli



Ancillary data

- Wind speed and direction
- Wave height
- Number of swimmers
- Rainfall amounts
- Flow and duration of WWTP overflows or metered outfalls
- Water-quality parameters

Concentrations of *E.coli*

BEACH	MEDIAN	MINIMUM	MAXIMUM	DAYS >235
	WATER--colonies per 100 ml			
Edgewater	86	9	830	7
Villa Angela	150	13	8,100	17
Sims 1	400	20	16,000	23
Sims 2	450	21	19,000	24
Sims 3	390	10	36,000	27
Sims 4	400	13	29,000	27
	SEDIMENT--colonies per gram per dry weight			
Edgewater	7	1	38	
Villa Angela	35	5	170	
Sims 1	150	2	8,000	
Sims 2	130	4	2,600	
Sims 3	72	2	7,200	
Sims 4	34	4	750	

Significant correlations for all beaches and areas at Sims

E. coli concentrations and

- Turbidity
- Antecedent rainfall
- Weighted rainfall

Significant correlations for some beaches and areas at Sims

E. coli concentrations and

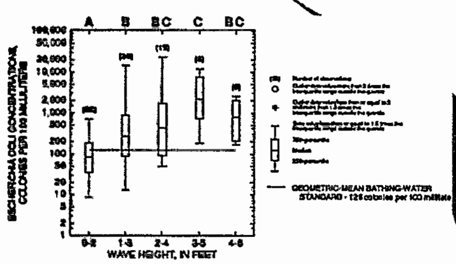
- WWTP overflows
- Resuspension of sediment bacteria
- Suspended-sediment concentrations

Weak or not statistically significant

E. coli concentrations and

- Wind direction
- Water temperature
- Number of swimmers

WAVE HEIGHT



Prediction of *E. coli* using multiple linear regression (MLR)

Determine the best set of explanatory variables

Explain the variation in *E. coli* concentrations, leaving as little as possible to unexplained "noise"

MLR Model

- Weighted categorical rainfall
- Beach-specific turbidity
- Wave height
- Y-intercept terms for each beach

Accounted for 58 percent of the variability in *E. coli* concentrations

Predictions of *E. coli* using the model at Edgewater Beach

Wave height (ft)	Weighted categorical rainfall (in)	Turbidity	Predicted *E.coli*	90-percent prediction interval	Probablity > 235
2-4	>0 to 0.5	25	130	9 - 1000	36
0-2	>0.5	10	68	10 - 470	14
1-3	0	30	40	6 - 260	6

Predictions of *E. coli* using the model at Villa Angela

Wave height (ft)	Weighted categorical rainfall (in)	Turbidity	Predicted *E.coli*	90-percent prediction interval	Probablity > 235
3-5	>0 to 0.5	40	1,600	52 - 48,000	82
1-3	>0.5	10	430	40 - 4,500	66
1-3	0	7	100	23 - 2,200	49

Correct and incorrect predictions

MODEL PARA-METER	DEFINITION	PREDICTIONS BASED ON	
		Edgewater-antecedent *E. coli*	All beaches-MLR model
Correct	Overall correct predictions	68	85
False	Predicted to be unsafe, but was safe	76	25
False negative	Predicted to be safe, but was unsafe	20	19

Conclusions

- MLR models based on water-quality and environmental factors predict *E. coli* concentrations fairly accurately
- More work needs to be done to improve predictive models
  - Add other variables
  - Validate from data collected during other recreational seasons

Donna S. Francy
U.S. Geological Survey
Water Resources Division

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Columbus, OH 43229
614/430-7769
dsfrancy@usgs.gov

Session Four:
Beach Advisories, Closures, and Risk Communication

Recreational Rates, Fish Consumption, and Communication

Joanna Burger
Rutgers University, Department of Biological Sciences

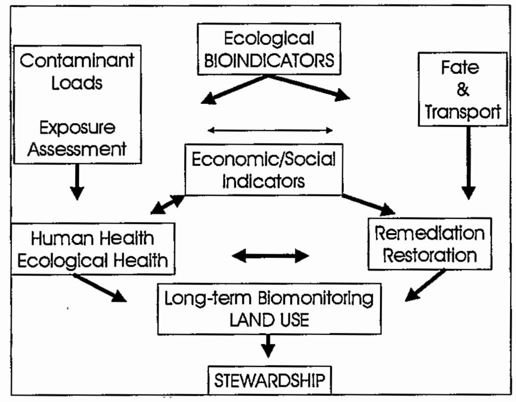
One key aspect of global change in coastal areas is a decrease in ecological integrity as more and more landscapes are developed, leaving a mosaic of intact refuges and degraded patches that may not be sufficient for conserving biodiversity. While increases in human population and shifts in the distribution of people affect land use, the temporary movement of people can have major implications for conservation and biodiversity. Tourism and recreation are on the increase worldwide and will continue to increase as global economies improve and leisure time increases. For the United States as a whole, walking is the most popular recreational activity, followed by sightseeing, picnicking, swimming, fishing, bicycling, and birdwatching. Some types of tourism and recreation are increasing more than others. Birdwatching, hiking, backpacking, downhill skiing, and primitive camping are the five fastest-growing activities in the United States, and many of these occur in coastal areas. In 1982, 21.2 million Americans (12 percent) were birdwatchers, while in 1995 the number had grown to 54.1 million (27 percent of Americans). Fishing is one of the most popular and important recreational activities, and it differs from many other activities in coastal regions because people consume the fish. The U.S. Environmental Protection Agency reported that the number of water bodies under fishing advisories rose by 14 percent from 1994 to 1995, and this represents 4 percent of the Nation's total river miles. All of the Great Lakes and their connecting waters, as well as a large portion of U.S. coastal waters, are also under advisories.

One fact that is clear from the wide range of studies on the perceptions of risk from eating fish is that the public consistently underrates or ignores the risk and continues to fish in contaminated waters, although this is partly a function of not communicating to the specific target audience. There is a gap between policy and practice. In this case, there is a discrepancy between the scientist and regulators' view of the risk from eating some fish and that of the general public; the public views eating such fish as less serious than does the scientist. Fish continue to be an important source of protein, leading to conflicting communication messages. Understanding of consumption advisories is often ethnically based, both in terms of understanding the advisories themselves and in evaluating the long-term health effects. One aspect of risk assessment and environmental management that is often ignored is the question of who receives the gains and benefits. The relatively low levels of interest in fish consumption advisories by the public can partly be explained by the gains that fishermen experience: they enjoy fishing, it gets them outdoors, it is an activity that can be done with every member of the family (regardless of sex or age), it can be done with friends, it can vary seasonally as well as by target fish, equipment, and method, and lastly, it provides food. Many of the reasons for fishing involve complicated social dimensions that may far exceed merely obtaining fish for consumption. The added benefit of supplementing the family food with fish is particularly important for some groups. Risk scientists, in contrast, often concentrate only on the latter benefit when computing risk and issuing advisories, spending most of their time with probability and magnitude, rather than including the more complex issues that people may use in evaluating risk. Recreational activities do not occur in a vacuum, but clearly involve a web of social factors that allow the fishermen to meet their social needs.

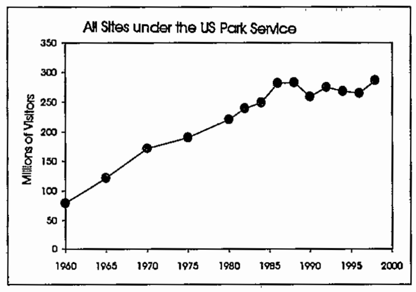
Recreational Rates, Fish Consumption, and Communication

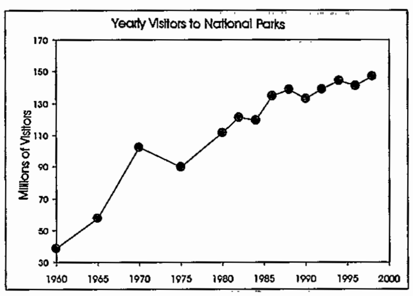
Joanna Burger
Rutgers University
Institute of Marine and Coastal Sciences
Consortium for Risk Evaluation With Stakeholder Participation

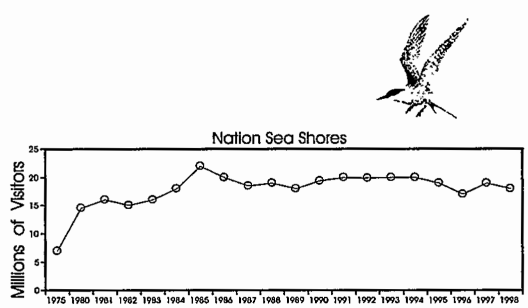
Funding NIEHS
CRESP
NJDEP

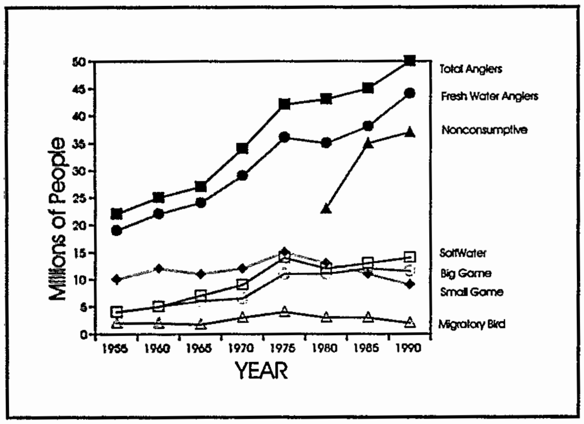


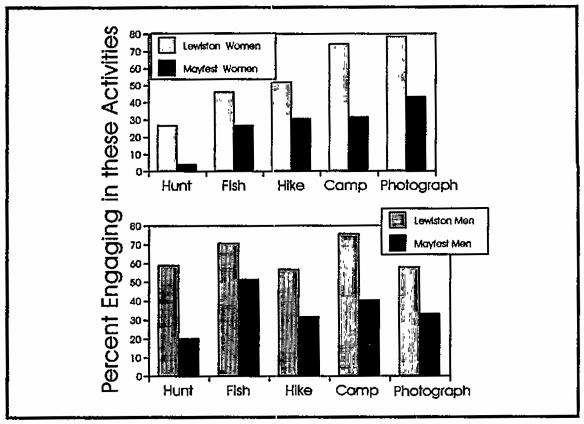
1. Recreational Rates
2. Perceptions about Estuarine Resources
3. Consumption Patterns and Risk
4. Communication and Risk

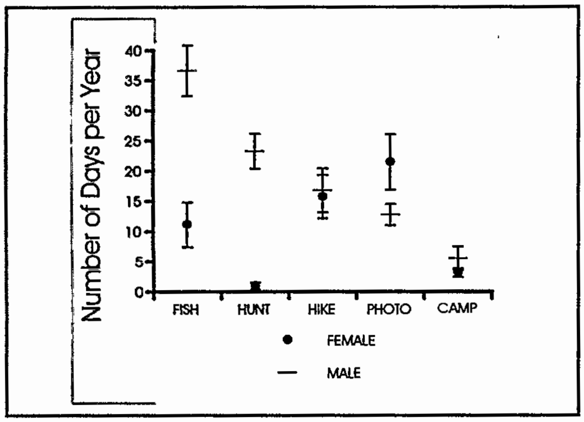


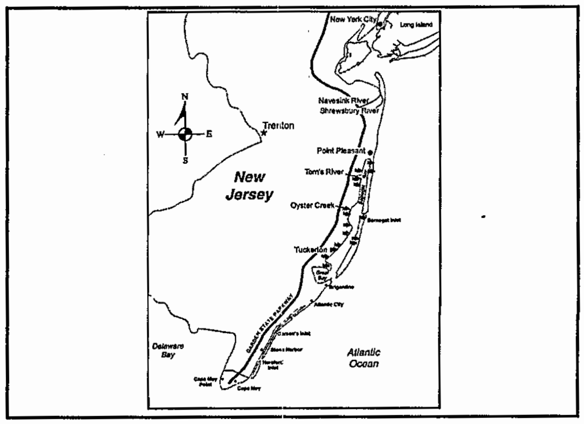


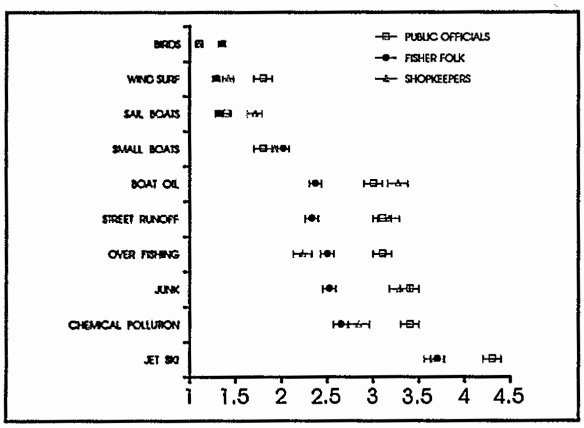


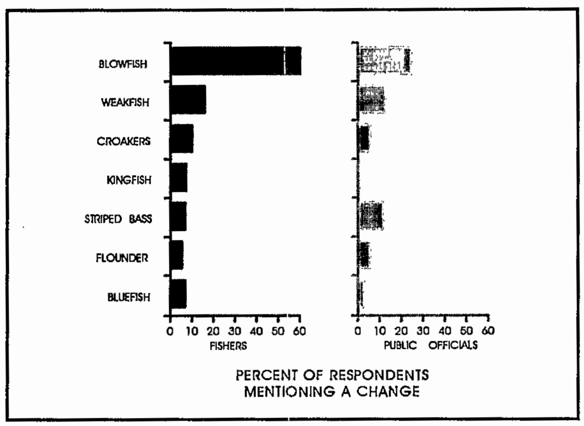

Millions of People
0
5
10
15
20
25
30
35
40
45
50
1955
1960
1965
1970
1975
1980
1985
1990
YEAR
Total Anglers
Fresh Water Anglers
Nonconsumptive
SaltWater
Big Game
Small Game
Migratory Bird

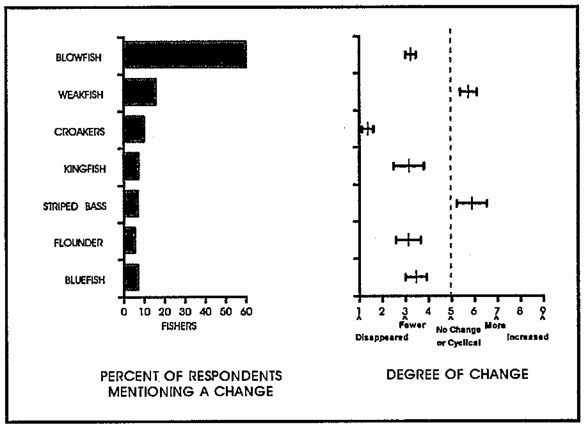

Percent Engaging in these Activities
Lewiston Women
Mayfest Women
Hunt
Fish
Hike
Camp
Photograph
Lewiston Men
Mayfest Men
Hunt
Fish
Hike
Camp
Photograph

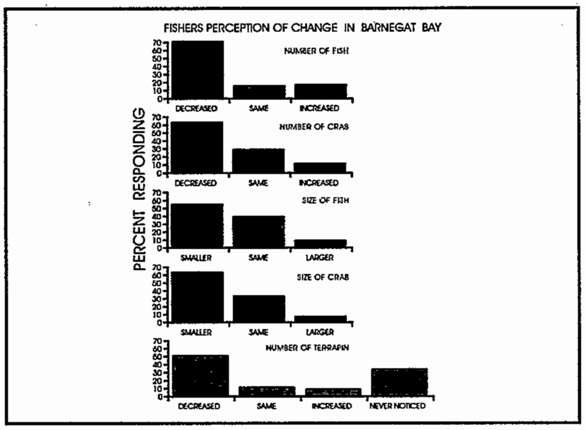

Number of Days per Year
0
5
10
15
20
25
30
35
40
FISH
HUNT
HIKE
PHOTO
CAMP
FEMALE
MALE

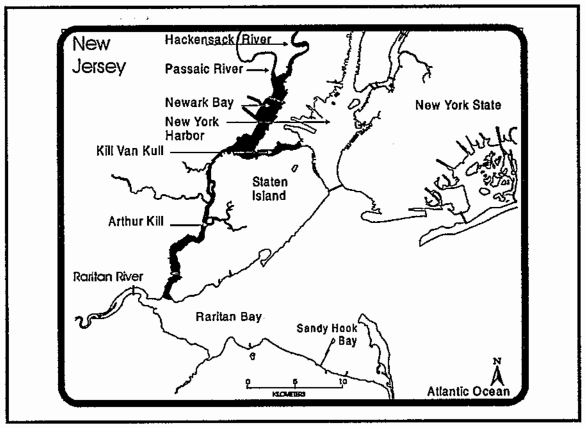

New York City
Long Island
Trenton
N
W
E
S
New Jersey
Point Pleasant
Oyster Creek
Tuckerton
Delaware Bay
Atlantic Ocean

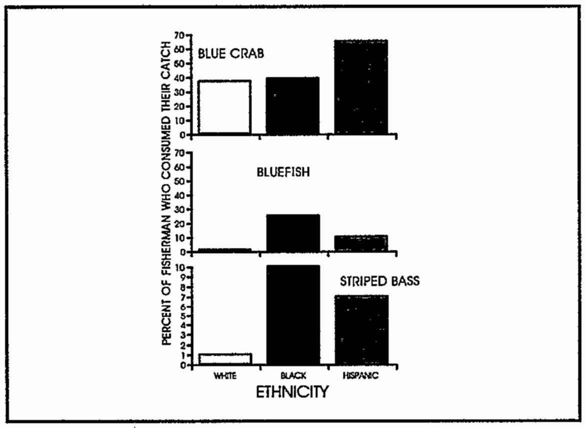

PUBLIC OFFICIALS
FISHER FOLK
SHOPKEEPERS
BIRDS
WIND SURF
SAIL BOATS
SMALL BOATS
BOAT OIL
STREET RUNOFF
OVER FISHING
JUNK
CHEMICAL POLLUTION
JET SKI
1
1.5
2
2.5
3
3.5
4
4.5

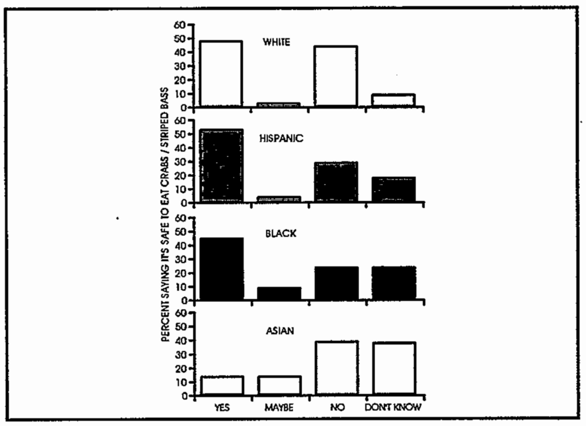

BLOWFISH
WEAKFISH
CROAKERS
KINGFISH
STRIPED BASS
FLOUNDER
BLUEFISH
0 10 20 30 40 50 60
FISHERS
0 10 20 30 40 50 60
PUBLIC OFFICIALS
PERCENT OF RESPONDENTS
MENTIONING A CHANGE

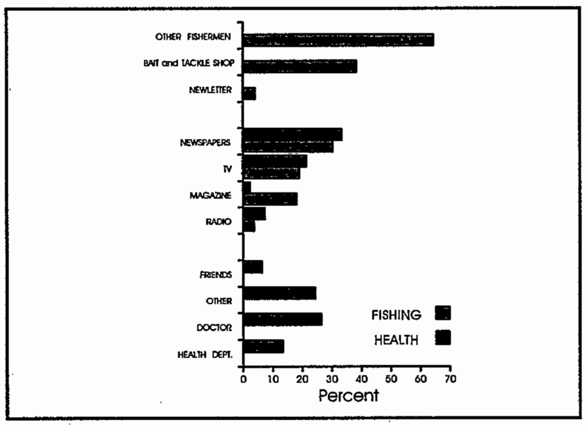

BLOWFISH
WEAKFISH
CROAKERS
KINGFISH
STRIPED BASS
FLOUNDER
BLUEFISH
0 10 20 30 40 50 60
FISHERS
PERCENT OF RESPONDENTS MENTIONING A CHANGE
1 2 3 4 5 6 7 8 9
Disappeared
Fewer
No Change or Cyclical
More
Increased
DEGREE OF CHANGE

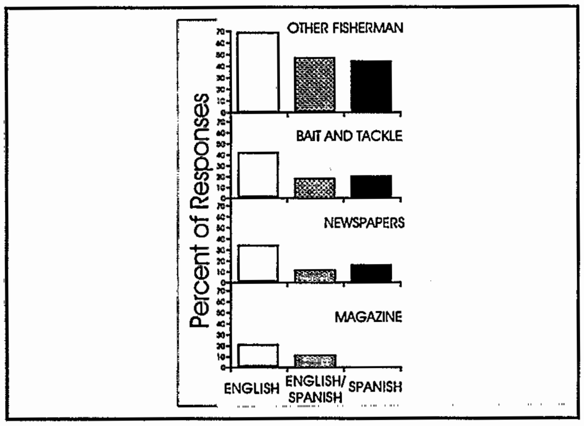

FISHERS PERCEPTION OF CHANGE IN BARNEGAT BAY
PERCENT RESPONDING
NUMBER OF FISH
DECREASED
SAME
INCREASED
NUMBER OF CRAB
DECREASED
SAME
INCREASED
SIZE OF FISH
SMALLER
SAME
LARGER
SIZE OF CRAB
SMALLER
SAME
LARGER
NUMBER OF TERRAPIN
DECREASED
SAME
INCREASED
NEVER NOTICED

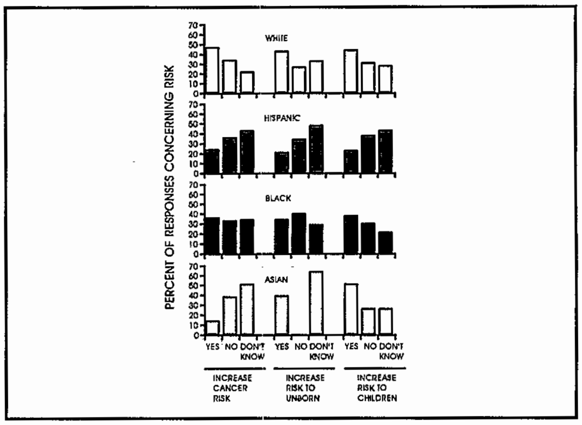

New Jersey
Hackensack River
Passaic River
Newark Bay
New York Harbor
Kill Van Kull
Staten Island
Arthur Kill
Raritan River
Raritan Bay
Sandy Hook Bay
New York State
Atlantic Ocean
N

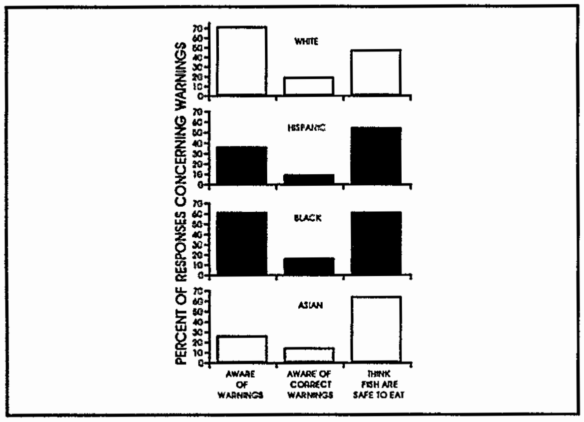

PERCENT OF FISHERMAN WHO CONSUMED THEIR CATCH
BLUE CRAB
BLUEFISH
STRIPED BASS
WHITE
BLACK
HISPANIC
ETHNICITY

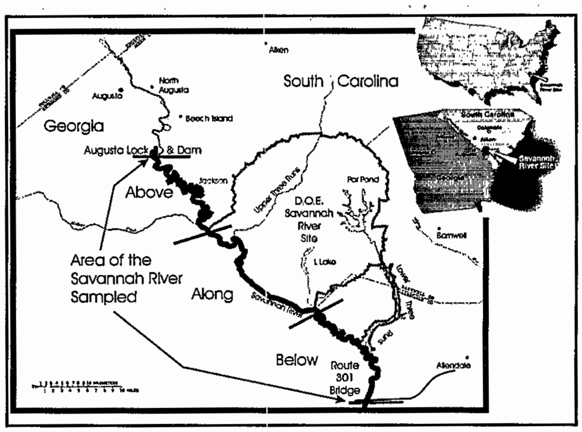

PERCENT SAYING IT'S SAFE TO EAT CRABS / STRIPED BASS
WHITE
HISPANIC
BLACK
ASIAN
YES
MAYBE
NO
DON'T KNOW

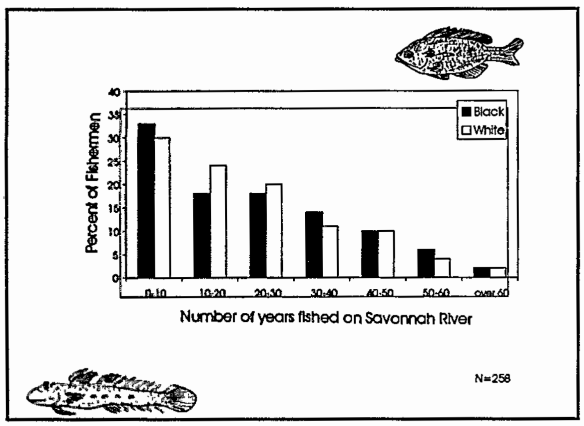

OTHER FISHERMEN
BAIT and TACKLE SHOP
NEWLETTER
NEWSPAPERS
TV
MAGAZINE
RADIO
FRIENDS
OTHER
DOCTOR
HEALTH DEPT.
FISHING
HEALTH
0 10 20 30 40 50 60 70
Percent

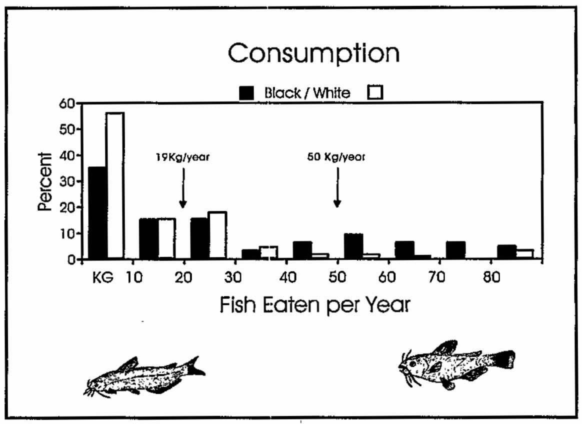

Percent of Responses
OTHER FISHERMAN
BAIT AND TACKLE
NEWSPAPERS
MAGAZINE
ENGLISH
ENGLISH/ SPANISH
SPANISH

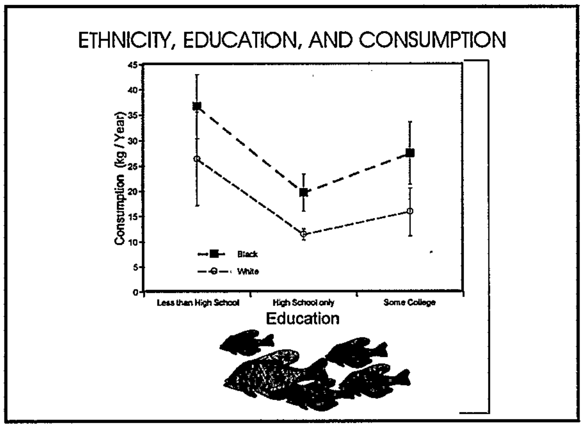

PERCENT OF RESPONSES CONCERNING RISK
WHITE
HISPANIC
BLACK
ASIAN
YES NO DON'T KNOW
INCREASE CANCER RISK
INCREASE RISK TO UNBORN
INCREASE RISK TO CHILDREN

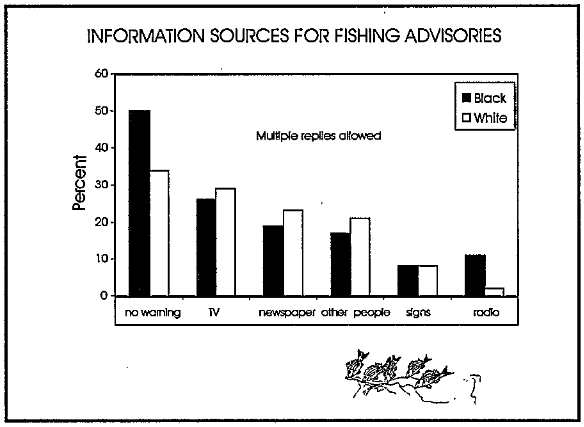

PERCENT OF RESPONSES CONCERNING WARNINGS
WHITE
HISPANIC
BLACK
ASIAN
AWARE OF WARNINGS
AWARE OF CORRECT WARNINGS
THINK FISH ARE SAFE TO EAT


South Carolina
Georgia
Aiken
North Augusta
Augusta
Beech Island
Augusta Lock & Dam
Jackson
Above
D.O.E. Savannah River Site
Par Pond
L Lake
Barnwell
Area of the Savannah River Sampled
Along
Below
Route 301 Bridge
Allendale
Savannah River Site


Percent of Fishermen
Black
White
0-10
10-20
20-30
30-40
40-50
50-60
over 60
Number of years fished on Savannah River
N=258


Consumption
Black / White
Percent
19Kg/year
50 Kg/year
KG
Fish Eaten per Year





Correct Knowledge about Habitat of Common Fish (%)

Species	Habitat	Fishermen	Staff	Students
Shark	S	99	100	92
Bluefish	S	99	86	59*
Flounder	S	97	86	66
Tuna	S	97	96	80
Swordfish	S	94	96	81
Cod	S	94	86	54*
Snapper	S	93	61	42*
Trout	F	85	86	71
Halibut	S	80	68	48*
Catfish	F	78	71	43*
Carp	F	76	61	37*
Pickerel	F	76	33	25*
Haddock	S	75	57	26*
Striped Bass	S/B	72	29	15*
Hake	S	67	36	20*
Tilefish	S	67	43	16*
Sunfish	F	65	64	48
Yellow-finned Tuna	S	65	29	15*
Perch	F	64	43	38*
Bass	F	47	75	60*
Salmon	B	40	61	42*
Tilapia	F	7	25	5*

S, F, and B refer respectively to saltwater, freshwater, and both

Correct Knowledge about Habitat of Common Fish (%)

Species	Habitat	Fishermen	Staff	Students
Shark	S	99	100	92
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Swordfish	S	94	96	81
Catfish	F	78	71	43*
Haddock	S	75	57	26*
Striped Bass	S/B	72	29	15*
Yellow-finned Tuna	S	65	29	15*
Salmon	B	40	61	42*
Tilapia	F	7	25	5*

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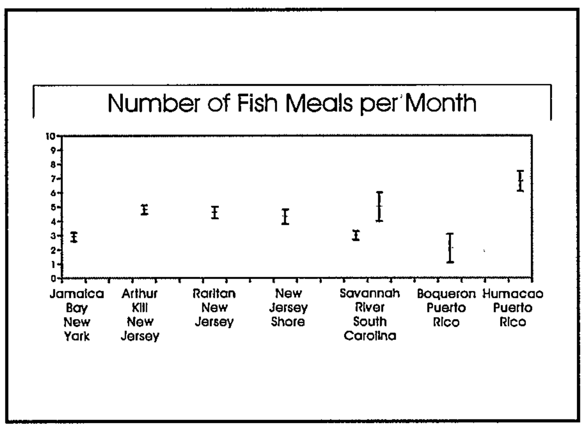
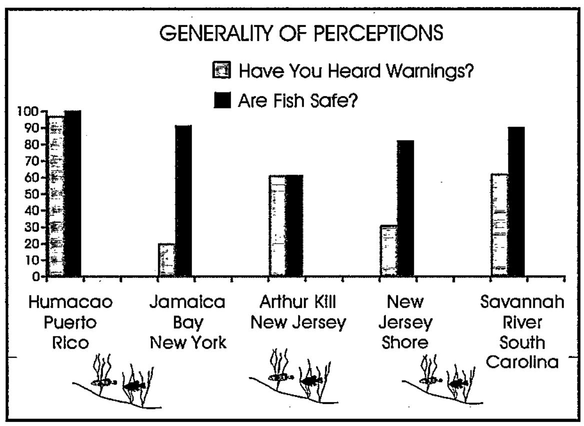




* Recreational Rates Are Increasing
* Conflicts Exist Among Users
* Perceptions Differ About Estuarine and Coastal Resources
  - State of the Resource
  - Health of the Estuary
  - State of the Conflicts
  - Safety of Fish Consumption

Florida's Beachwater Web Site

Robert Nobles
Florida Department of Health, State Health Office

Florida's gulf and ocean beaches are principal components of the state's successful tourism industry. Unfortunately, various media reports have indicated that the bacteriological quality of many of Florida's beaches is not routinely evaluated. To combat negative media reports and to protect the health of the public, the Department of Health began development of a statewide beachwater sampling program. Without proper funding and statutory authority it was impossible to implement a uniform statewide marine water monitoring program. As a result, a Pilot Beach Water Sampling Program was developed by the Department of Health, Bureau of Facility Programs, under a grant sponsored by the Department of Community Affairs, Florida Coastal Management Program, and the National Oceanic and Atmospheric Administration (NOAA). This $50,000 grant was allocated for one year, which began July 1, 1998, and extended through June 30, 1999. Five representative coastal counties were selected for participation: Broward, Okaloosa, Pinellas, Sarasota and Volusia. Upon completion of the Pilot Monitoring Program, the Florida Department of Health secured a $95,000 grant from the U.S. Environmental Protection Agency for one year beginning July 1, 1999, and extending through June 30, 2000. This beach water sampling and public notification program was developed to serve an additional purpose, which was to determine levels of bacteria in the surf of Florida beaches during dry weather and wet weather conditions. EPA preselected six cities and associated counties according to specifications of the beach EMPACT program: Clearwater-Pinellas County, Tampa/St. Petersburg-Hillsborough County, Miami/Miami Beach-Dade County, Ft. Lauderdale-Broward County, West Palm Beach/Boca Raton-Palm Beach County, and Jacksonville-Duval County.

Once selected, the county health departments in each of the participating counties were required to monitor 8 to 10 beachfront sites along the counties' coastline every other week. Counties selected the sampling sites according to heavy recreational use, history of problems, proximity of point source outfalls, direct impact by land-based pollution, limited tidal flushing, and accessibility to bathers. Once the water quality samples were collected, county staff were then required to transport the samples to a Department of Health-certified laboratory within six hours of collection and at a standard temperature of four degrees Celsius. The laboratory analyzed the samples for enterococcus using the EPA approved and recommended Method 1600, which is a 24-hour membrane filter test method. After laboratory analysis, county health department staff obtained the results and forwarded them to local media contacts for publishing and to the State Health Office for Internet posting, which are both required under the grant specifications.

The Florida Department of Health beach web site was designed as the foundation of our public notification process allowing residents and tourists to view the water quality in various areas around the state. Using Front-page 98, the web site has been the DOH icon for water quality for the past two years. Upon visiting the web site, you will find a beautiful map of Florida with the counties sampling for enterococcus highlighted in red and yellow. From the homepage, you are able to go to a number of locations within the web site. By clicking on one of the associated counties, you will be able to view a map of that county with the sampling points indicated, the name of the beaches for that county, and a water quality rating for each beach area sampled for the most recent sampling date. A link to the history page for that county can then be viewed by clicking "previous history" in the top left of the page. From the history page, the option to visit another county or to return to the homepage exists by using the Java script drop-down box. From the homepage, a description of the study can be viewed by clicking on "This years study." The headings found within this location of the site are study overview, study participants, indicator organism and analysis, sampling protocol, data interpretation, public notification, and question/comment contacts. Also from the homepage, a link to the National Center for Genome Resources can be obtained by clicking on the word enterococcus, which gives a biologic description of enterococcus. Information about the DOH Pilot Beach Water Sampling Program is also located on the web site. By clicking "Click here to view data from last year's study," last year's web site can be viewed, which includes maps and sampling histories for the participating counties. The complete summary of all of the data and the findings for the Pilot Study can be viewed by clicking on "Pilot Study." Within this site an executive summary and approximately 17 pages of data interpretations and Department of Health projections can be viewed.

The information provided is a summary of the Department of Health beach water sampling and public notification programs. The web site was created for the public, and any suggestions or comments regarding the functioning and/or the layout of the site are welcomed and will be greatly appreciated. (www.doh.state.fl.us - then use the drop-down box to go to "Beach Water Quality.")

Questions/Comments

If you have any questions, comments, or concerns, please feel free to contact Robert Nobles at the Bureau of Facility Programs – State Health Office by one of the following methods:

1. E-mail: robert_nobles@doh.state.fl.us
2. Phone: (850) 487-0004
3. Fax: (850) 487-0864
Mail: Department of Health
Bureau of Facility Programs
2020 Capital Circle, SE BIN A08
Tallahassee, FL 32399-0700

Florida Beach Web site

...an important part of our public notification process

Presented by: Robert Nobles

Florida Department of Health
State Health Office
Division of Environmental Health
Bureau of Facility Programs

Please see www.doh.state.fl.us for more detailed information

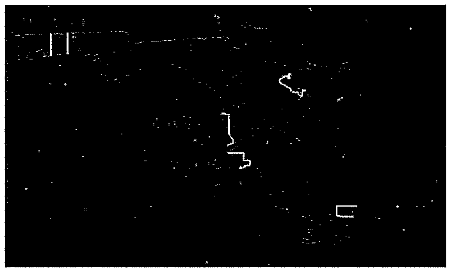
Florida's Beach Water Sampling

- Florida's beaches classified as "Bum Beaches"
  - only 13 of the 35 coastal counties reported beach sampling in 1997
  - no statewide standardization of sampling methods, indicator organisms, sampling frequencies, or laboratory methods
- July 1, 1998 The Pilot Beach Water Sampling Program developed

Pilot Beach Water Sampling Program 1998-1999

- 5 counties selected
  - Broward, Okaloosa, Pinellas, Sarasota, Volusia
- Each county required to monitor 8 beachfront sites along their county's coastline biweekly
- Funding $50,000
- General public notified of results via local newspapers or the Internet site (www.doh.state.fl.us)

1998- 1999 Participating Counties

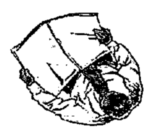


Beach Water Sampling Study and Public Notification Program 1999-2000

- 6 Counties Involved
  - Broward, Dade, Duval, Hillsborough, Palm Beach, Pinellas
- Funding: $95,000
- 10 sites sampled biweekly

Public Notification Program

County Sampling
↓
Lab Analysis
↓
CHD Director
↓
Broadcast Media | Print Media | State Health Office



State Health Office
↓
Web Site
Local & State Residents
Visitors & Tourists

EPA Enterococci Limits for Marine Water

- Good = 0-34 Enterococci per 100 ml of marine water
- Moderate = 35-103 Enterococci per 100 ml of marine water
- Poor = 104 or greater Enterococci per 100 ml of marine water

Broward County -- Ft. Lauderdale Area Beaches

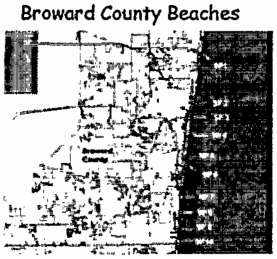
Previous Weeks' Results for 1999

Sample Points	7/12/99	7/26/99	8/9/99	8/23/99
Deerfield Bch Park	Good	Good	Good	Poor
Pompano Blvd, Pompano Bch	Good	Good	Good	Good
Harrison St, Hollywood	Good	Good	Good	Good

*Please see web site for other sampling points and counties

Current Results of a Few Beach Water Sampling Points in Broward County

Broward County Beaches



Sampling Points (SP)	Current Results
1.Deerfield Bch Park	Good
3.Pompano Blvd, Pompano Bch	Good
9.Harrison St, Hollywood	Good

Current as of 9/20/99

*Please see website for other sampling points and counties

Conclusions/ Recommendations

- Overall project objective of 1998 pilot program not achieved
- Did complete several tasks
  - development of standardized methods, selection of monitoring sites, use of a standard reporting format, documentation of sampling results and conditions, and time-efficient public notification

Questions?/Comments

Contact Robert Nobles

- email robert_nobles@doh.state.fl.us
- phone: (850)487-0004
- S.C.: 277-0004
- Fax: (850)487-0834 S.C. 277-0834
- Mail: Department of Health
  Bureau of Facility Programs
  2020 Capital Circle SE BIN A08
  Tallahassee, Florida 32399-1710

Florida Monitoring and Coordination Efforts

Paul Stanek
Florida Department of Health, Pinellas County

Pinellas County is located in west-central Florida. Most of the county is surrounded by water. Pinellas County has a number of different types of beaches, including barrier island beaches, mainland beaches near Tarpon Springs, intercoastal beaches, and bay beaches. Pinellas started sampling total and fecal coliform in 1978 and continues today. The sampling includes intercoastal beaches, barrier island beaches, mainland, and bay beaches. Samples are collected twice a month, with half of the county being sampled in the first half of the month and the rest sampled at the end of the month.

In 1998 and 1999, Pinellas County was one of the initial five county health departments selected in the state to participate in the enterococcus sampling project. This sampling occurred biweekly at eight sites for one year. The sites included three barrier island, three bay, and two intercoastal, which were spaced geographically to get a good representation of the water quality in Pinellas County. In the 1999-2000 enterococcus sampling, Pinellas County was one of six county health departments sampling 10 sites biweekly for one year. One of the two new sites that will be sampled is the outfall of John's Pass to capture tidal effects. The other site that will be sampled is a highly used beach area, the Gandy Beach. As part of the requirements for the enterococcus study, the sample results must be published in a press release every two weeks. Due to the timing of the results, high numbers indicate that the beach should have been closed last week. This poses a problem when people are allowed to use the beach because of the delay in getting the results.

Pinellas County used to notify people about the sample results by fax, but now we send out e-mails because the list of recipients keeps growing. Pinellas County's water quality is generally good. When the project first started, it got a lot of publicity, but after that it did not have a regular place in the newspaper. The only times the sampling press release made it to the paper was when the results were bad. No matter what the press release said, the headline would read "Intestinal bacteria found off six beaches," which made the phone ring off the hook.

The way people use the beach and who uses the beach affect the sampling results. One of the big visitors to the beaches in Pinellas County is pelicans (birds). They leave their droppings, which may result in high sample counts. Also, many people bring pets to the beach. People bring dogs, birds, snakes, and horses to some of the beaches.

Pinellas County undertook the healthy beaches mission for both the people and the environment. An inherent problem is that the current methods are reactionary. We are telling people they shouldn't have used the beach last week. An ideal solution is to predict conditions with a real-time or near real-time analytical model. This model would take into account tidal effects and rainfall to predict the risks of swimming in the water. The current situation is that there is no national or Florida program to consistently sample and also develop a model to predict risks. Additionally, there are no mandatory standards for testing. Current laboratory methods are also debated.

The key to water quality is the determination of appropriate indicators for microbiological water quality in relation to the occurrence of pathogens in Tampa Bay watersheds and beaches. This is a top priority.

In many areas, beach managers don't really want to close beaches. In Pinellas County, there are certain beaches for which we would like to permanently post advisories, but the beaches do have a use. They're places where people like to go so we do not want to keep people off of them, but we would like to advise them of the risks. Water quality isn't the only thing considered in the Healthy Beaches Program; drowning prevention, mercury in fish, sanitation facilities, and bilge water from ship ballast are also of concern.

At the beginning of the Healthy Beaches Program, we got together with the University of South Florida, Florida Marine Research Institute, USGS, Tampa Bay Estuary Program, Mote Marine, Florida Aquarium, Clearwater Marine Science Center, and the Center for Marine Conservation to set up the program. We also have cooperation with the St. Petersburg/ Clearwater Convention & Visitor's Bureau to recognize the problems and help seek solutions when necessary.

Healthy Beaches is in the midst of Phase I and has received money to do an assessment of indicator organisms and source and fate of enterococcus. Phase II will go to the Florida legislature for a budget appropriation. This phase will develop a water quality model for risk assessment of pathogenic microorganisms commonly found in Florida waters. This phase will also include investigating the development of biosensors and other rapid response technology for timely quantitative analyses.

PINELLAS COUNTY

HEALTHY BEACHES

PROGRAM

Healthy Beaches

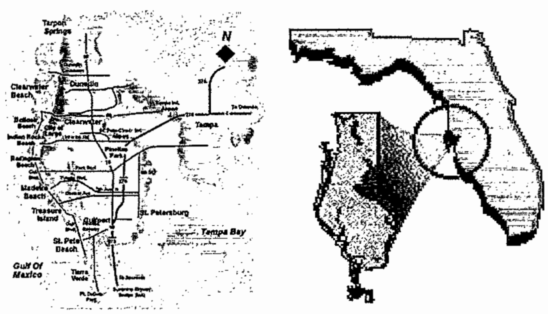
Pinellas County Health Department
Environmental Engineering Division

Paul Stanek
Manager, Healthy Beaches Program
727-538-7277 X 134
paul_stanek@doh.state.fl.us

East Coast Regional Beach Conference

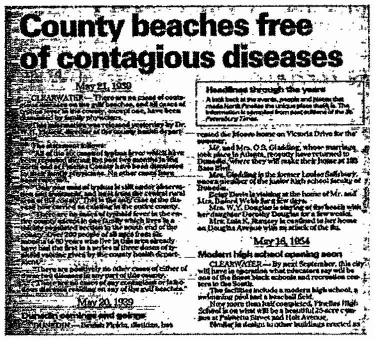
Florida Monitoring and Coordination Efforts

Pinellas County Florida



Pinellas County History

St. Petersburg Times
May 30, 1999



County beaches free of contagious diseases

May 21, 1939

Headlines through the years

May 16, 1954

Modern high school opening soon

May 20, 1939

What Does the Pinellas County Health Department Do?

Pinellas County's sampling program started in 1978 and tests over 50 sites monthly for total & fecal coliforms

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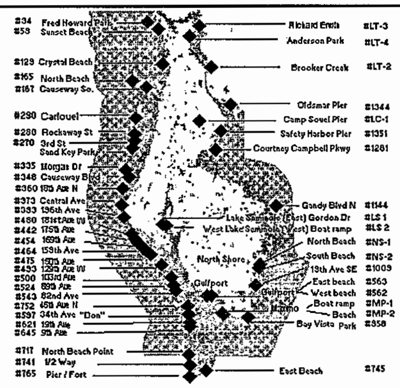
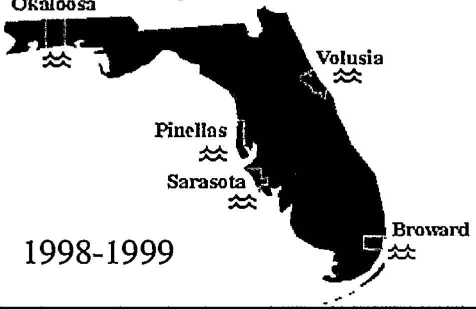
Total and Fecal Coliform Sampling Locations in Pinellas County

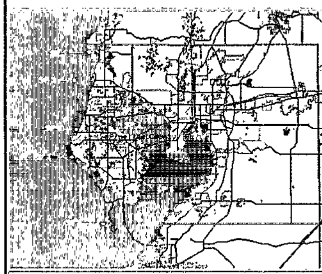


Pinellas Is One of 5 County Health Departments Throughout the State, Evaluating Enterococcus.
8 samples, biweekly, 1 year



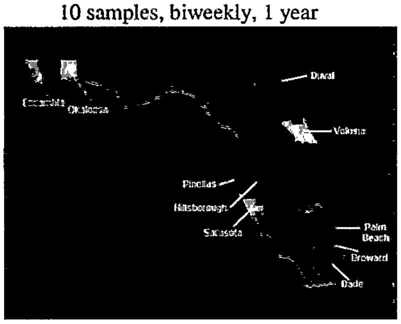
1998-1999

Enterococcus Results on DOH web site

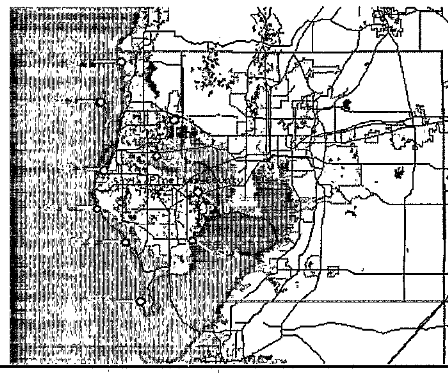


Pinellas County -- St. Petersburg and Tampa Bay Area Beaches	Sample Points	Results
	1. Fred Howard Park	Good
	2. Honeymoon Island	Good
	3. Belleair Shores N.	Good
	4. Indian Shores	Moderate
	5. Ft. Desoto Park	Good
	6. N. Shore City Bch	Good
	7. C. Campbell Cy	Good
	8. R.E. Olds Park	Good

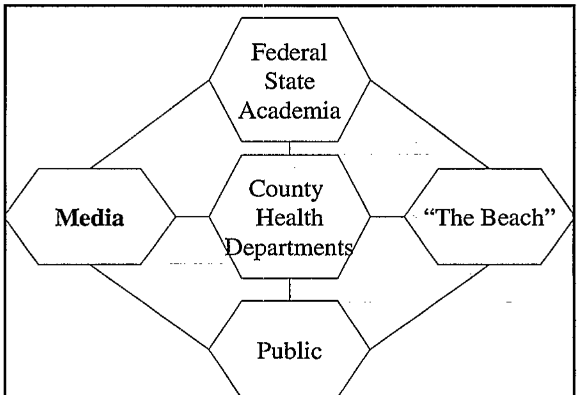
Pinellas Is One of 6 County Health Departments Throughout the State, Evaluating Enterococcus.
10 samples, biweekly, 1 year

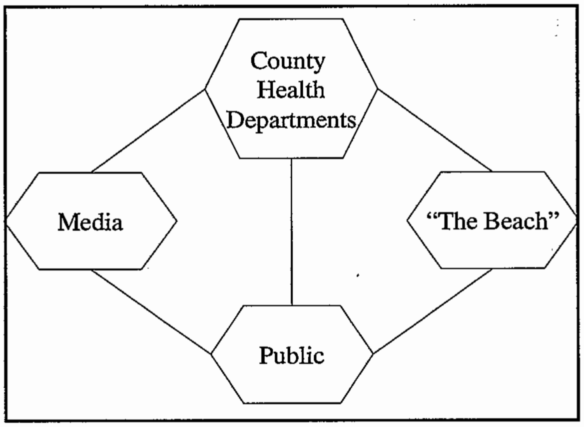


Enterococcus Sampling Sites



Communication





Sample Press Release

Beach Water Quality Monitoring:

A Pilot Research Project

Samples Collected Tuesday September 22nd, 1999

The Pinellas County Health Department is currently involved in a biweekly pilot study of local beaches to evaluate a bacteria as a possible indicator of water quality. Pinellas County along with five other counties across the State are participating in a pilot water testing program sponsored by the United States Environmental Protection Agency (EPA) and the Florida Department of Health (DOH). The aim of this project is to evaluate a specific bacteria by monitoring the level of the bacteria at coastal beaches. The specific bacteria being evaluated for use as an indicator of overall water quality is *Enterococcus sp.* *Enterococcus sp* are microorganisms that are found in the intestines of humans and other animals, and are commonly used as indicators of fecal pollution in drinking water. For questions or concerns please contact the Environmental Engineering Division of the Pinellas County Health Department, (727) 538-7277, or visit the Department of Health's web site: www.doh.state.fl.us, click on the drop down arrow next to "-Choose Subject-" and then select "Beach Water Quality"

Location Number	Location Name	City	Bacteria Count	Water Quality
PC-1	Fred Howard County Park	Tarpon Springs	4	Good
PC-2	Honeymoon Island State Park	Dunedin	2	Good
PC-3	Belleair Beach Intercoastal (North side)	Belleair Beach	16	Good
PC-4	Indian Shores County Access	Indian Shores	4	Good
PC-5	Fort Desoto County Park	St. Petersburg	14	Good
PC-6	North Shore City Beach	St. Petersburg	4	Good
PC-7	Courtney Campbell Causeway DOT	Clearwater	20	Good
PC-8	R. E. Olds City Park	Oldsmar	2	Good
PC-9	Treasure Island Beach	Treasure Island	4	Good
PC-10	Gandy Beach	St. Petersburg	<2	Good

Bacteria counts are based on the amount of *Enterococcus sp* per 100 milliliters of marine water.

Suggested Water Quality Levels used for this Pilot Research Project:

Good = 0-34 *Enterococcus sp* per 100 milliliters of marine water
Moderate = 35-103 *Enterococcus sp* per 100 milliliters of marine water

BRIEFLY

Eight beaches tested, found safe for swimmers

PALM HARBOR — Water tests taken Aug. 4 at eight Pinellas County beaches showed generally low levels of enterococcus, a bacteria found in the intestines of humans and animals.

All the beaches were deemed safe for swimming. The beaches tested were Fred Howard Park in Tarpon Springs, Honeymoon Island State Park in Dunedin, Belleair Shore (Intracoastal beach), Indian Shores, Fort De Soto Park, the beach at North Shore Park in St. Petersburg, Courtney Campbell Parkway in Clearwater and R.E. Olds Park in Oldsmar.

The highest bacteria count was found at North Shore Park city beach, but even it was in the moderate range. The county will conduct the water tests every two weeks with a grant from the National Oceanic and Atmospheric Administration.

For information, call the Pinellas County Health Department's environmental engineering division at (727) 538-7277 or check the test results on the state Department of Health's Web site at www.state.fl.us/health/beach/.

Farmer's market dispute ends in fatal stabbing

TAMPA — A 58-year-old man died from stab wounds he suffered in a crowded parking lot early Friday, police said.

Harvey Floyd argued with a man at the farmer's market parking lot at 30th Street and E Hillsborough Avenue, and threatened him with a pipe, witnesses told police. The other man then stabbed Floyd in the stomach sev

St. Petersburg Times August 8, 1998

PINELLAS DIGEST

Intestinal bacteria found off six beaches

Low levels of enterococcus, a bacteria found in the intestines of humans and animals, were detected in the water of six of the eight Pinellas County beaches tested Sept. 29. The water tested at the Courtney Campbell Parkway in Clearwater and at North Shore Park in St. Petersburg showed higher levels of the bacteria, but county health officials say they have no plans to shut those beaches down. The county will conduct water tests on the same eight beaches every two weeks with a grant from the National Oceanic and Atmospheric Administration. The beaches tested are: Fred Howard Park in Tarpon Springs, Honeymoon Island State Park in Dunedin, Belleair Shore (Intracoastal Beach), Indian Shores, Fort De Soto Park, R.E. Olds Park in Oldsmar, North Shore Park and Courtney Campbell Parkway. For information, call the Pinellas County Health Department's environmental engineering division at (727) 538-7277 or check the test results on the state Department of Health's Web site at www.state.fl.us/health/beach/

'Frog Prince' set to hop in Tarpon Springs

TARPON SPRINGS — The Frog Prince Puppetry Arts Center & Theatre will celebrate its 11th anniversary with a puppet show, workshop and refreshments at 2 p.m. Oct. 25. *The Frog Prince*, a full-length feature presentation of the classic fairy tale, will be given first. The show is recommended for children 5 years old and older. The cost for all events is $6 for adults and $4 for children 12 and younger. Reservations are necessary and may be made by calling (727) 942-2222 or (727) 784-6392.

Where the Gospel is spoken in Spanish

An increasing number of Spanish-language churches are popping up in Pinellas County. RELIGION, BACK PAGE

St. Petersburg Times October 17, 1998

BEACHES

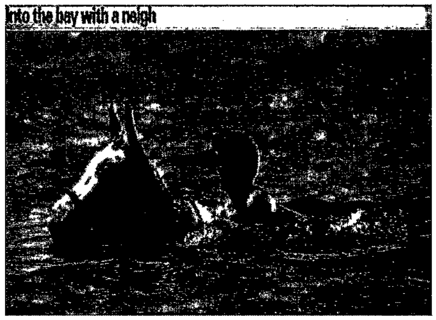
BEACH USAGE AND

WATER QUALITY

(We are not alone)

St. Petersburg Times September 12, 1999

St. Petersburg Times September 12, 1999



St. Petersburg Times July 17, 1999

The Mission…..

Healthy Beaches for People and the Environment

Inherent Problem

- Current methods are reactionary

Ideal Solution

- Ability to Predict Conditions
- Identify Risk BEFORE Exposure Takes Place
- Real-Time or Near Real-Time Analytical Methods Would Trigger Warnings or Closures and/or Set in Motion a More Rigorous Monitoring Protocol

Current Situation

- No National or Florida Program (no $)
- No Mandatory Standards for Testing
- Unexplained Bad Sampling Results
- Debate over Laboratory Methods (Most Probable Number (MPM) Vs. Membrane Filter (MF) methods)

Keys to Water Quality

- Determination of the appropriate indicators for microbiological water quality in relation to the occurrence of pathogens in Tampa Bay watersheds and beaches is a top priority.

Tentative Issues & Concerns

- Alternatives to Beach Closures
- Classifications of Beaches Based on Intended Use
- Indigenous Pathogenic Microorganisms
- Parasites in Sand and Water
- Storm water Runoff
- Consumption of Seafood (Mercury, Toxins)
- Ultraviolet Radiation & Cancerous Melanoma
- Injuries from Wildlife
- Drowning Prevention
- Sanitation: Public restrooms
- Bilge Water from Ship Ballast

Beginning of Healthy Beaches Initiative

•Excellent facilities nearby - USF, FMRI, USGS (PORTS system) Tampa Bay Estuary Program, Mote Marine, FL Aquarium, Clearwater Marine Science Center, CMC

•Developed Phase I "Indicator Organisms"

•St Petersburg / Clearwater Convention & Visitor's Bureau recognized problem

•As did Pinellas County Government, saw potential to cooperate with Tampa Bay Estuary Program

Phase I - Bacteria Sources and Fates

Combined study, by USF Marine Science Dept
head researcher Dr. Joan Rose

1 Indicator Organism Assessment:
Tampa Bay Estuary Program

2. Sources and Fate
SWFWMD SWIM Program
Tampa Bay Estuary Program

3. Enterococcus in Pinellas Source Evaluation
Pinellas Hotel & Motel Assn.
TOTAL: $170,000

Phase II - LBR for Pathogen and Risk Assessment Model

1) Develop water quality model for risk assessment of pathogenic microorganisms commonly found in Florida waters
2) Investigate and develop, where feasible, biosensors and other rapid response technology for timely quantitative evaluation of human pathogens
3) Generalization of the results of the Tampa Bay Water Quality Assessment Model for application statewide based on local conditions
4) Develop statewide strategy for integrated risk management involving the various stakeholders
PHASE II TOTAL: $835,000

Question-and-Answer Session

Panel: Joanna Burger, Robert Nobles, and Paul Stanek

Q (Lou Glatzer, University of Toledo, Lake Erie Center): This is a general question. I'm relatively new to this, and it may be directed to the speakers or anyone else here. I'm very confused about the variety of use of the terms "advisories" versus "closings." The question that I have is: Is there a source, whether it's on the Web or the written word, for finding out how many different approaches there are to advisories versus closings in the various counties, municipalities, and states?

Joanna Burger:

EPA does a summary every year about fishing advisories and consumption advisories, and they usually put out a bulletin in which they say how many state waters, how many lakes, what percent have advisories, what the advisories are due to, what percent are due to mercury, what percent are due to PCBs, and so on. That gives you an idea of the number of advisories, and then they often tell you how many there were in the previous year or the previous 2 years.

Q (Lou Glatzer): What I'm really asking about is the variety of political approaches by the different municipalities, counties, and states with regard to, well, do we say anything. Do we give an advisory, let people make their own decisions, or do we say "thou shalt close the beach" period, exclamation point?

Robert Nobles

I can speak for what I have seen in various counties around the state of Florida, but I think EPA representatives will want to speak for the nation.

Comment (Rick Hoffmann, USEPA, Office of Science and Technology): EPA looked at its fish consumption advisory program as a model for setting up the beach advisory program. EPA started doing fish advisory work almost 10 years ago. One of the first things we did in that program was to find out what people were already doing. And I think for the beach program, we are in the same initial phase since we have been under way a little over 2 years. Before we draft formal federal guidance, we want to know what formal guidance may be in effect at the state or local level. Charles Kovatch [of EPA] is compiling a summary of existing guidance. One of the things we are going to look at is whether there is a formal definition of what constitutes an advisory and a closing and that sort of thing. We have also asked people in a national survey whether they have advisories and closings. But your point is actually very well made. We are in a discussion right now with the state of California because they just recently passed state legislation that defines the types of actions taken and they make distinctions between advisories, postings, and closings. So they have three different categories. And one of the things that we will try to do is, first of all, identify what people use, how they define those, and then try to make some federal recommendations to improve consistency. But at the moment, there is no consistent usage at least that I am aware of. And I am not sure within the state of Florida itself.

Robert Nobles:
It's very true. In the state of Florida, right now, it's based on a county-to-county basis. Currently, only 15 of the 35 coastal counties sample beach water. In those counties that sample, some use fecal, some use total, and some use enterococci. A lot don't feel comfortable with using enterococci to post advisories or to close beaches. Some counties don't even feel comfortable closing beaches, period. A legislative budget request has been proposed, and I think that this year we might get the statutory authority to run the beach sampling in the state of Florida. Right now, it's a county-by-county basis and the only funding has been through grants. Since basically what you're saying is true, county-by-county, they pick who wants to post an advisory, who has the most power in that county. If the hotels and the tourist people have more power than the department of health, then no advisories will be posted because it will lose business. This is what we have found thus far. Until we get a little authority all around the state of Florida, it's ambiguous.

Joanna Burger:
I think that's a problem not just in the state of Florida. I've been out doing some of these surveys and seen state officials in New Jersey post the fish consumption advisories and a half an hour later had the local municipality officials come around and take down the signs. And when you ask them why, they say, "We don't want to scare people. We don't want people not to come here to fish anymore. This is our business." So there is a real problem between jurisdictions and what different agencies are interested in.

Robert Nobles:
Also, one county posted an advisory and I got a newspaper article back saying that the person who was swimming, as we've seen from Joan's presentation, said, "Well, if the Department of Health was really concerned about our health, they would rope off the beach." So, posting advisories just doesn't work out. I guess that for some areas you would have to use red tape if possible.

Comment (Mike Flannery, Pinellas County Health Unit): I just want to add to that a little bit. Another level of it is defining what the beach use is. I don't think "one standard fits all" really works. You saw Gandy Bridge in my presentation. You saw the use and the type of people who use it. That's probably one of our most popular beaches. I think that we have three of them like that on the causeways. The local residents, younger people with their dogs, this is their life to them. And if we make this standard that is really designed for maybe older people or a tourist area, make it uniform, I don't think it really does the purpose of a beach. What's the beach for? It's so people can enjoy the water. And the perfect way to make it so that they will never get sick is to make sure that they never go into the water. At some place there must be an inter-level between those two. We have not had reports of diseases from the Courtney Campbell Causeway or any of those causeways. And we do have cases, say of Vibrio, occurring on the most pristine beaches. So, I'm looking at a program eventually that might have an area that is for recreational dogs and everything else at some level posting an advisory on that, one that's more like a tourist area, and a third might be for pristine beaches where nobody should really be there at all, like where the wildlife is natural in that area.

Robert Nobles

Mike and I talk about the future of beach sampling within the state of Florida all the time, so this isn't anything new. But, my opinion on the matter and what I am going to be pushing for is that, no matter who goes to the beach, if it's a tourist or if it's a resident, we are going to protect them the same. I can agree only so much. Okay, the dog is in the water and you like your dog in the water, but, if your child gets sick as a result, no matter what economic status you come from, it doesn't really matter. So, saying we'll relax some of the rules at this beach, we'll just let them know that you can get sick. People take their own risk anyway, and that's the way the state is going to approach it. But right now, we don't have any authority so I guess in Pinellas County, until next year or the year after, you can do as you see best.

Q (Geoff Grubbs, USEPA, Office of Water): First thing to say is that it is really nice work on the presentation that you guys are doing. But I am curious about, both from the state level and the county level, when you find a problem, what you then do internally in your state or county to track that back to the source and to in some way effect change at the source to abate the problem in the near or long term.

Paul Stanek:

That is a good question. In the short term, really we just go out and resample. We want to verify our results since what we are doing is not a perfect science and it's something that's been evolving. It's something that we are not really sure about. We are going to go out and resample and check to make sure that we are doing things right and that our lab is doing things right and then go from there, most times we're not able to track back to a source. We don't have the funds to do that for starters, and part of our Healthy Beaches initiative is to do that and find out where we are getting those bacteria from.

Robert Nobles:

And I may sound redundant, but I often do. On a statewide level, the results come back to me. If I see that something is contributing to pollution, as in Davis Island in my presentation about Tampa Bay, right now we just monitor it and we notify. What do we do as a result? We have epidemiologists in the counties that can go look and do an assessment of the situation, but right now, it is on a county level. Truthfully, without any money, we cannot, as the state, provide any additional funds to the counties saying that, "Okay, you had bad hits, bad hits, bad hits, and now, let's go out and find it." They document on every sampling occasion what the different environment is around the site. Not only the stuff that I mentioned in my presentation, but they look around. I visited a couple of sites where we have wastewater treatment plants 200 yards off of where we sample. The beach manager believes that the mist off of the top, depending on the wind direction, can cause the water results to become high. I mean, we don't really know. The first thing that we need to do in the state of Florida is to see if we have a problem (1) by monitoring, (2) by informing, and (3) by looking at causation. That is the approach that we have to take, and without funding, that is the only thing that I can really say.

Paul Stanek:

It also kind of goes back to the counties being able to do it. Right now, there are just a select few that think it's important or they have gotten some money from Tallahassee or EPA to do the sampling. But right now, the majority of them aren't.

Q (Matt Liebman, USEPA, Region 1): I have a question for Robert about your web site and your general notification program. By the way, I thought that your web site is excellent. I had a question regarding the three levels of notification—good, moderate, and poor. I am just wondering what your response is from the public when they see something that says "moderate," for example. Our experience, or many people's experience, is that the public might just want to know if it's safe or it's not safe. So there is this level of inbetweenness. I'm just wondering.

Robert Nobles:

I don't know if you're the person who called earlier in the week or somebody else. But the same question came up when we started. The same question came up from the counties. The way it was set up, and knowing the science background, [with] the geometric mean of 35 in one month, we're not achieving. We're not sampling five times in one month. We can't. We're sampling two times in a month, five times in two and a half months So we are using the one-time count of 104. I'm bringing into the picture the moderate as 35-103 because 104 is the action level based on one-time sampling. This is what we're using. The counties are prompted to post advisories or to resample. But what do I say to the public if they call or what do I answer to you now? I'll say that the risk is moderate if we sampled five times or if you look at the trend because I can do a geometric mean for two and a half months. But looking at the trend, 35-103, you have a risk of swimming in the water, as much of a risk as anything. It's not as great as at 104, but you have a risk. People can get sick. It might not be 19 per 1,000, but you do have a risk of getting sick. You need to take that into consideration whenever you go into the water. But if you look through the web site, you can choose another beach to go to. I'm not promising that just because we sampled and gave the beach a good rating that the beach will still be good when you go on the weekend. I'm supposed to post the readings from earlier in the week, and the water quality right then will be good. So, ambiguously, I answered like that and hope that they can come back with another question for me to help them.

Q (Kim Mikita, Florida Coastal Management Program): I actually got to review the quarterly reports from the pilot program and so I know that there is some trouble with one of the counties reporting their results in the newspaper. I was wondering if you are having that kind of trouble this year, as well, and if you ever figured out why that one county, that shall remain nameless, didn't report their results?

Robert Nobles:

You reviewed the quarterly reports and the final report, I'm sure, with the 18 pages of attachments. I agree, reporting *is* difficult. I'll name the counties. I don't mind. It was difficult for reporting to occur in Sarasota County. It was difficult for reporting to occur in Pinellas County. Once you start sending out press releases, as Paul stated, the press just wants to know if it's bad. Their view is: "We already know that the water is good, why state it? Why have it in the newspaper?" It takes extra initiative and a whole lot of cooperation from the local jurisdictions to actually have the media post the readings. This year's reporting was the second part of your question. No, it hasn't been published in the newspapers. We've just received articles stating that we started a new program; EPA is funding this; they might have messed up here and there; we have five counties; we have this much money, etc. Anyway, it's all a matter of priority for that county and right now, no, it's not being published everywhere. We usually just get articles here and there when it's bad. For example, after the Super Bowl, when readings are 2,000 in Tampa Bay, or if a hurricane caused bad sampling results. It wasn't a priority for the media, so the reporting is based on priority right now. It's unfortunate, but hopefully, if it takes me calling all of the newspapers in the counties to have them report results, I will.

Q (Paul Kuehnert, State of Maine Bureau of Health): I have a question primarily for Dr. Burger. You did a great job telling us, to generalize from what you presented, that we're not being successful in getting these messages across. I think that both in terms of fish advisories and water safety issues, they are fairly complex messages and we have complex and conflicting interests in our communities. I'm just wondering if you have, based on your experiences so far, figured out some things that might be suggestions for what works?

Joanna Burger:

There are a lot of things that work. All of the studies that I talked about are, of course, much more complex than I can present. That is why there are reprints over here if people would like them. In the case of one of the studies that we did in New Jersey, we followed up the study on whether people knew that there was a cancer risk and so on. In that same questionnaire, after we finished the questions that we wanted to ask, we actually told the people we were talking to what the state advisories were—that the state advisories were to eat this much fish or not that much fish and that they were based on risk to the fetuses and that older adults were not at risk in general from eating fish, that it was primarily a developmental problem. And then we asked people a couple of questions after that regarding whether or not they would change their fishing behavior and whether or not they would have their pregnant wives or wives of childbearing age change their behavior. Everybody said "yes." Part of the problem was communicating the message that it's particular people that are at risk, not everybody, and that you can moderate your risk by eating smaller fish rather than larger fish. The classic fisherman is bringing home the biggest fish possible because I can show that I caught a big fish. But if you start showing people that in fact they can catch the big fish but take home the smaller ones to eat, people are receptive to that. But, we haven't given them that kind of complex message.

The other thing that I would say is that in the study we did in South Carolina the objective was to find out what people were eating and what the different risk factors were. This summer, we went back to the same population with our two-page fish fact sheet, which was written based on the kinds of things we found out from people. It was written in a very simplified manner. There were pictures of fishermen on the fact sheet, and it talked about how fish was very good for you, but that there were some risks and you could reduce those risks by eating plant-eating fish rather than carnivorous fish and things like that. So, we showed the fact sheet that we had written as a result of this to the individual fishermen and asked them to read it and then we went away and came back in 10 minutes later and then asked them some questions about it. And several interesting things came out from doing that approach. In other words, this was not just putting them into somebody's office but actually going back out on the river with little forms and giving them to people who are fishing. Some of the things that we found out were: first of all, everybody read it. Out of 50 people that we asked, only 1 person said, "I'm too busy to do this." Now that is pretty amazing. If you went into the supermarket and gave them a two-page thing to read and said that we are going to come back in 10 minutes and ask you some questions, how many people would say, "No"? Only 1 out of 50 said that they were too busy. Everyone else read it and then when we came back, they answered our questions. The second interesting thing that came out was everybody asked if they could have three or four to take back and give to their friends and family. So, people want something that is understandable—that's not so full of gobbledy-gook that it goes on for 18 pages. You can tell all of the risk information in 18 pages and have everything covered, but no one's going to read it or very few people will read it or fewer people will read it, let's put it that way. Everyone read this and they asked for more copies, so it's not a question that people don't want to know and don't want something that they can read. I think we haven't been, in some cases, addressing the audience. We've been doing what we would think is appropriate and what as scientists we want to do, which is always go with every contingency. It's the same thing with the web. If you look at the web sites they're developing, they're not making them so complex that people can't get the message right away. I think that there's a lot of good messages that we can give people about eating fish. We don't have to tell them not to eat fish. We have to tell them enough information so that they can make their own risk decisions and so they themselves are under control about how they can reduce their risk. There are lots of ways that people aren't aware of.

Robert Nobles:

I just wanted to say something to the people who came down from Canada because I've been seeing articles about Key West. First, let me thank the EPA for giving $20,000 so that we can actually sample in Key West. Second, they did have a leaky sewer pipe problem. They're trying to fix it now, and the articles from New York stating that Key West is gone to the birds are not necessarily true. It will be cleaned up soon. The state is actually spending a lot of money to help Key West fix this problem. So, next year you all can come back.

Summary of Breakout Groups

Each breakout group was asked to answer the following questions for each of the four topic areas:

1. Are there any additional major topics that should be included in the guidance?
2. What are the major issues you're facing under each of these topics?
3. Where do you need more information or guidance to help you address specific issues?
4. What specific recommendations would you like to see included in the guidance document?
5. What would you like the document to look like in terms of format and structure to be most useful to you?
6. Recognizing that additional research can be conducted on all of the issues, what immediate research needs do you think are necessary for effectively implementing beach water quality programs?

The following answers provide recommendations under each of the major topic areas:

Microbial Indicators

1. Discuss alternative indicators and analytical methods
   - identify others besides fecal coliforms, bacteria, or viruses
     - note that enterococci does not capture water quality
     - investigate the usefulness of cyanobacteria (floatables, chemicals, harmful algal blooms)
   - DNA fingerprinting and other new technologies
   - naturally occurring pathogens
2. Determine the health impacts of storm water
   - conduct more research
   - require peer review of future data
3. Study and develop thresholds for indicators across temperature and regional variations
   - use eco-region approach
   - consider that different bacteria behave differently
   - take into account naturally occurring bacteria
4. Develop a matrix of comparative studies (recognize that one water quality indicator across the nation will not work)
   - include general information and a table of given factors
     - discuss precision of techniques (false-positives and false-negatives)
   - clarify the health risks and limitations associated with each indicator and their relation to gastrointestinal disease and other diseases
   - compare approved/recommended methods (e.g., enterococci, Enterolert®, Colilert®, MPN-most probable number)

- describe how the indicator results can be used for beach and non-beach areas, recreational and non-recreational waters, and shellfishing areas
  - full versus partial body contact
  - explore if indicators for shellfishing or nonrecreational waters can be used for swimming areas
- validate methods
- include historical studies

5. Allow for professional judgement and site-specific variations
6. Develop a rapid indicator test
   - note that Method 1600 is not specific enough for immediate public advisories (false negatives)
   - EPA/FDA cooperate in "dipstick" development (FDA developing one for *E. coli* detection in meat)
7. Describe the relationship of molecular techniques to disease and indicators
8. Provide guidance for the transition from current to proposed criteria and the implementation of standards
   - explain how to compare old data to chart improvement in water quality
   - discuss how shellfish managers, source water protection managers, recreational water managers, TMDL developers, NPDES permit authorities, marine managers (floatables and marine sanitation devices), and storm water dischargers compare information if each uses different indicators for bacteria
   - describe how actions of agencies will be coordinated (state, federal, and local)
   - provide guidance on the transition to new standards, indicators, and methods
   - address exotic pathogens
   - provide case studies of those states that have successfully changed their water quality criteria from total coliform and fecal coliform to enterococci and *E. coli.*
9. Research the life cycles of the indicators and pathogens
10. Provide criteria for monitoring for other indicators (e.g., sediment, turbidity, wind, climate, birds
11. Conduct a round-robin/intercalibration study of nationwide laboratories for each method to detect microbial indicators

Water Quality Monitoring

1. Encourage watershed monitoring and allow for flexibility in each program
2. Promote frequent monitoring
   - infrequent monitoring doesn't capture the variability of water quality
   - encourage the development of baseline studies
3. Offer clear direction and justification for the frequency and location of water quality sampling
   - consider time of day for a single sample
   - address details of sample methodology
     - geometric mean or single sample
     - depth of the sample
     - wet weather events
     - number of samples per beach
     - spatial frequency
     - personal protective equipment
   - seasonal variation in sampling techniques
   - develop protocol for how to take samples under variable conditions

- discuss interpretation of results
  - geometric mean
  - high single sample threshold exceedances
4. Develop a QA/QC table format for water quality monitoring and laboratory analysis
   - address the appropriate use of:
     - trip blanks
     - sampling protocols
     - field collection data sheets
     - indicator screening
     - chain-of-custody procedures
5. Identify funding sources to support water quality monitoring
6. Recognize that sanitary surveys and monitoring need to work together and provide guidance

Predictive Tools

1. Create a model that takes many environmental factors into account
   - e.g., turbidity, temperature, sediment influences, wind, climates, seabirds, wildlife, domestic animals, CAFOs
   - include information on how to interpret model results and/or health risk factors for disease
   - include more than one indicator (*E. coli* and other EPA-approved indicators)
   - validate model so it can be used to close beaches
   - provide costs
     - what is lost because of closings
     - lost tourism
     - illness
     - lost time at work
   - base tools on a good sampling program and analysis and consider all variables
   - make data collection and models affordable
2. Identify and define components of a good water quality model (e.g., what to look for, contacts for more information, different kinds of models [hydrodynamic or static], different uses [regional management or contingency plans])
3. Allow for flexibility
   - use predictive models in lieu of sampling
   - use models for a preliminary step in source identification
4. Describe how to manage using predictive models
5. Develop predictive tools to provide information for action prior to exposure

Risk Assessment, Management, and Communication

1. Create a Risk Index or Beach Index (similar to the UV Index)
   - clarify the risks in a simple manner (safe versus unsafe)
   - make it uniform across the country - poor, moderate, good
   - develop minimum signage requirements
2. Develop a uniform procedure for conducting epidemiology studies
3. Develop methods to quantify exposure and designated uses
   - describe what risk factors are equated to indicator values without being overly conservative

- health risks may vary under different conditions (full body contact versus partial body contact)
- effects of morbidity and mortality

4. Recognize that management is site-specific
   - encourage preventive actions (minimize exposure, use soap after exposure, etc.)
   - encourage remediation and control measures
5. Develop procedures for closing and reopening a beach
   - investigate the flag system (Europe)
6. Determine whether there is a risk factor with bird, mammal, or other non-human versus human feces and adults versus child
7. Develop recommendations for a beach closing
   - address the use of predictive models or real-time assessments
   - consider post-event evaluations
     - designate uses based on water quality monitoring [303(d)and 305(b)]
8. Recommend good communication techniques
   - use television weather reports
   - use newspaper and the Internet
   - address how to communicate with different audiences
   - use permanent signs at some beaches warning of risk especially after rain
   - develop outreach materials to explain risk and encourage reporting of illness associated with swimming exposure
   - establish a dial-in number to report swimming-related illnesses
9. Compare risk to land use, point versus nonpoint sources, human versus other species, and meteorological events.
   - describe cost and benefit assessment of the value of monitoring and closing a beach
10. Define a closing, advisory, reopening, posting, public beach, sanitary survey, and bathing beach.
11. Study use and interpretation of a distribution (range) of threshold values versus single number.

Additional Topics and Recommendations

1. Use the bottom-up approach (local-state-federal)
2. Conduct more research on contaminated sediments (toxins and pathogens in the swash zone) and remote sensing
3. Encourage the implementation of source control measures after monitoring discovers problems
4. Include other programs such as storm water monitoring, sanitary surveys, septic tank management, benefit assessments (economics), and state reports on swimming-related illnesses
   - describe roles of each player
5. Provide additional national or regional meetings to discuss issues and implementation of the guidance
6. Include a 1-paragraph statement describing the diverse conditions and public health problems to confirm that the managers know their waters
7. Make EPA the clearinghouse for beach-related information including monitoring, indicators, risk assessment, and models
8. Separate freshwater and marine water sections

9. Create the guidance document in a software format and in a three-ring binder
10. Develop a generic fact sheet describing the risks of using a beach near areas with high concentrations of wildlife or using a beach after rain.
11. Define the responsible agency (funding, monitoring, etc)
12. Describe the procedures for disease outbreak, tracking, and investigation
13. Create a procedure for measuring overall program effectiveness
14. Include a synopsis, glossary, and frequently-asked-questions sections
15. Be sure that language/terms are consistent so that health departments can understand the storm water regulators
16. Provide national and regional meetings

Speakers' Biographies

Joanna Burger, Ph.D.

Dr. Burger is a distinguished Professor of Biology in the Division of Life Sciences, and in the Environmental and Occupational Health Sciences Institute, at Rutgers University. She received her B.S. in Biology from the State University of New York at Albany, her M.S. in Zoology and Science Education from Cornell University, and her Ph.D. in Ecology and Behavioral Biology at the University of Minnesota in Minneapolis. She has taught at Rutgers for 25 years, where she conducts research on social behavior of animals, ecological risk, and effects of contaminants on behavioral development. For the past 15 years, Dr. Burger has been involved with examining recreational subsistence fishing, in terms of recreational rates, consumption patterns, sources of information, risk to human consumers, and methods of risk management. For the past 5 years she has been involved with the development of ecological risk methods for Department of Energy sites, including evaluating attitudes toward recreational and ecological services, and future land uses. Her main research interests are fate and effects of contaminants, biomonitoring, social behavior, environmental attitudes and perceptions, risk perception, and risk analysis.

Rebecca Calderon, Ph.D.

Dr. Calderon is currently the chief of the Epidemiology and Biomarker Branch in the Human Studies Division of EPA's National Health and Environmental Effects Research Laboratory. This is the first time in 10 years that the Epidemiology Program has had a permanent leader. She has revitalized epidemiology at EPA by converting the program from primarily an extramural program accomplished through cooperative agreements and grants to primarily an intramural program that is conducting studies led by EPA's own intramural epidemiologists and biomarker scientist. Recent accomplishments in the Epidemiology Program include the following: the first study to examine endemic microbial enteric illness attributed to drinking water in a U.S. population, the first study to examine possible causal hypotheses of health effects associated with particulate matter air pollution by examining new physiologic parameters in the elderly, and the first well-conducted U.S. study to examine health effects associated with arsenic in a nonoccupational population. Dr. Calderon received her M.S. in Microbiology from the University of Rhode Island in Kingston in 1979. She received an M.P.H. specializing in infectious disease epidemiology from Yale School of Public Health in 1981 and a Ph.D. in Epidemiology from Yale University, New Haven, Connecticut, in 1986.

Al Dufour, Ph.D.

Dr. Dufour is currently the director of the Microbiological and Chemical Exposure Assessment Research Division of EPA's National Exposure Research Laboratory. He earned his B.A. in Biology and Chemistry from Northern Michigan University, his M.P.H. specializing in epidemiology and environmental health services from Yale University, and a Ph.D. in Microbiology from the University of Rhode Island. Dr. Dufour was with the U.S.

Public Health service for 4 years and then joined EPA in 1970. His research interests are analytical microbial methods development; microbial risk assessments related to recreational, drinking, and shellfish harvesting waters; and human exposure associated with waterborne and airborne microbial pathogens.

Donna Francy

Ms. Francy received a B.S. in Biology from Indiana University and an M.S. in Environmental Science from Rice University. She has been working for the U.S. Geological Survey for 10 years and has served as project chief on a variety of projects investigating the processes that affect the presence of bacterial indicators and pathogens in ground water and surface waters.

Geoffrey Grubbs

Mr. Grubbs directs the Office of Science and Technology at EPA headquarters in Washington, DC. He works with engineers, scientists, and economists to set regulations requiring best available treatment of water pollution from all kinds of point sources; set criteria and standards for pollutants in rivers, lakes, estuaries, and other waters under the federal Clean Water Act; and establish the science for regulating safe levels of contaminants in drinking water under the federal Safe Drinking Water Act. Mr. Grubbs has an engineering degree from Princeton University.

Phil Heckler

Mr. Heckler is the deputy director of environmental affairs of the New York City Department of Environmental Protection. He is involved in all facets of wastewater issues, including construction, design, operation, and policy. He is currently responsible for the New York City Harbor Survey, which monitors water quality. Mr. Heckler has a B.S. in Civil Engineering from the University of Missouri.

Paul Horvatin

Mr. Horvatin has been with EPA for 23 years and is currently the chief of the Monitoring, Indicators, and Reporting Branch of the Great Lakes National Program Office. He manages Great Lakes monitoring programs for GLNPO, such as the Integrated Air Deposition Network, fish contaminant monitoring program, and open water monitoring using the Research Vessel *Lake Guardian*. He is also involved in binational developmental work with Canada on ecosystem indicators for the Great Lakes through the State of the Lakes Ecosystem Conference process.

Jake Joyce, Ph.D.

Dr. Joyce is currently assigned to EPA Region 7 in Kansas City, Kansas. He is assigned to the Water, Wetlands, and Pesticide Division, where one of his ancillary duties involves being the regional BEACH Coordinator. Dr. Joyce began his governmental career during the Viet Nam era as a green beret weapons specialist cross-trained as a medic. He then accepted a commission into the U.S. Public Health Service and was assigned to the U.S. Coast Guard in New York City as an environmental/occupational health officer. He has also served as a supervisory sanitarian for the Indian Health Service and as an environmental health scientist for EPA's Toxic Substances and Disease Registry in Kansas City, Kansas. Dr. Joyce earned a B.S. in General Science from Marywood College in Scranton, Pennsylvania, and an M.S. in Environmental Biology from Hood College Graduate School in Frederick, Maryland. He also holds another master's degree in Environmental Health Science and a Ph.D. in Environmental Health Science from New York Polytechnic in Brooklyn, New York.

Fred Kopfler, Ph.D.

Dr. Kopfler is one of the original staff members of EPA. Prior to the formation of EPA, he worked for the Agricultural Research Service and the U.S. Public Health Service. Dr. Kopfler spent almost 20 years in EPA's Office of Research and Development investigating health effects associated with chemical contaminants in drinking water. He joined the Gulf of Mexico Program in 1989 and is currently the co-leader of the Public Health Focus Team. He is responsible for developing and implementing the Public Health Operational Performance Plan. He is also the team leader of the Science and Technical Services Team. This team oversees the scientific peer review for the Gulf of Mexico Program Office, facilitates the Scientific Review Committee, and manages the Quality Assurance Management Program.

Arnold Leder

Mr. Leder has worked in the water enforcement program in EPA Region 5 for the past 25 years. He is currently a program manager with several areas of responsibility, including Concentrated Animal Feeding Operation enforcement. He is an agency representative to the *E. coli* Task Force, an interagency effort attempting to deal with beach closures in the Indiana portion of the Lake Michigan Basin. As a member of the task force, he has focused his efforts on ensuring that major and minor dischargers comply with NPDES permit requirements, including CSO controls.

Matthew Liebman, Ph.D.

Dr. Liebman is an environmental biologist at EPA's New England regional office in Boston. He received his B.A in Biology in 1980 from Carleton College in Minnesota and his Ph.D in Ecology and Evolution from the State University of New York at Stony Brook in 1991. Since 1990, Dr. Liebman has worked at the EPA office in Boston as a project manager and scientist in the National Estuary Program and the Dredged Material Disposal and Monitoring Program, and as a water quality specialist. He is the regional coordinator for EPA's BEACH Program, Nutrient Criteria Initiative, and National Sediment Inventory. He has conducted or been involved in research efforts in the fields of parasitology, marine ecology, disposal site monitoring, and water quality.

Tom Mahin

Mr. Mahin received his B.S. in Environmental Engineering from the University of Texas at Austin in 1983. He is chief of the Municipal Services Section of the Massachusetts Department of Environmental Protection's largest regional office. He is the cochair of the DEP's Pathogens Work Group, a group of specialists from different sections within DEP. He is coauthor of an article on waterborne pathogens published in the April 1999 issue of *Water Environment & Technology*. Mr. Mahin's areas of specialization include pathogen indicator issues at bathing beaches and water quality impacts from municipal storm water discharges.

Robert Nobles

Mr. Nobles is an Environmental Specialist III within the Bureau of Facility Programs in Florida. He has been with the Bureau for 2 years, working on establishing marine water sampling criteria and a statewide protocol for sampling. As a portion of the public notification process, Mr. Nobles (along with the Bureau's web manager) developed a web site that provides updates from beach sampling around the state. He has a B.S. in Molecular Biology and is an M.P.H. candidate at Florida A&M University, Institute of Public Health.

Joan Rose, Ph.D.

Dr. Rose is a full professor in the Department of Marine Sciences at the University of South Florida. She is a member of the American Academy of Microbiology and was recently appointed to the Water Science and Technology Board for the National Academy of Sciences, National Research Council. She is past president of the Florida Environmental Health Association. Dr. Rose, who has been in Florida for 10 years, has more than 120 publications in the field of water pollution microbiology and public health risk assessment.

David Rosenblatt

Mr. Rosenblatt is the chief of the Atlantic Coastal Bureau, Division of Watershed Management, in the New Jersey Department of Environmental Protection. He received his B.S. in Environmental Science from Rutgers University and an M.A. in Teaching from the College of New Jersey. For the past 20 years he has evaluated nearshore coastal water quality and developed pollution response and remediation programs, including New Jersey's Cooperative Coastal Monitoring Program for recreational beaches. He continues to manage beach quality programs in addition to watershed planning and management in the Atlantic coastal region.

Steve Schaub, Ph.D.

Dr. Schaub joined EPA's Office of Science and Technology in 1992 as a senior microbiologist for drinking water regulation support. He coauthored EPA's Beach Action Plan and served as the EPA representative to the President's Council on Food Safety. Prior to joining EPA, Dr. Schaub served as a Microbiology Program Officer for the U.S. Army Medical Research and Development Command from 1972 to 1992 in field water supply and sanitation. He worked on microbiological methods, military equipment evaluation, and the effectiveness of land application of wastewater. Dr. Schaub also studied microbiological pollution in the Great Lakes with the U.S. Public Health Service from 1964 to 1966. He holds a B.S. in Microbiology from Washington State University and a Ph.D. in Microbiology from the University of Texas.

Paul Stanek

Mr. Stanek is the manager of the Health Beaches Program in Pinellas County, Florida. He has worked for the Pinellas County Health Department for the last 10 years in a variety of programs, including pools-bathing places, septic tanks, pollutant storage tanks, public and private drinking water, and finally the beach program. Mr. Stanek earned his B.S. in Biology from the University of South Florida in 1988.

Jeffrey Waters

Mr. Waters is the project director at the Lake Pontchartrain Basin Foundation in Metairie, Louisiana. He received his B.S. in Geology from the University of Southern Maine and his M.S. in Geology form Northern Arizona University. He is currently enrolled as a Ph.D. candidate in the Department of Geology and Geophysics at the University of New Orleans. He worked for 3 years as the staff scientist at the Tulane University Environmental Law Clinic prior to joining the Lake Pontchartrain Basin Foundation. For the past 5 years he has managed more than 20 water quality and habitat restoration projects for the Foundation. Mr. Waters' main research interests are aqueous geochemistry and the fate and transport of contaminated sediments in coastal environments.

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