Chapter 5

Improvements to Methodologies and Techniques for Monitoring Coastal Recreation Waters

EPA has also been working to improve the science and integration of monitoring and modeling for pathogens in coastal recreation waters. Chapter 3 describes some of EPA's efforts in this area. This chapter describes other EPA efforts to improve monitoring and recommends improvements to methodologies and techniques for monitoring coastal recreation waters.

5.1 What monitoring research has EPA conducted?

EPA's Office of Research and Development (ORD), in coordination with the Office of Water, conducted a study to identify the characteristics of a beach environment that have a significant impact on monitoring in coastal recreation waters. This project examined five beach environments to determine the factors that most influence the measurement of beach water quality. Two ocean beaches, an estuarine beach, a Great Lakes beach, and a riverine beach were selected to provide as broad a representation of beach environments as possible. The following sites participated in this study (Figure 5.1):

- West Beach, Indiana Dunes National Lakeshore, Ogden Dunes, Indiana, a freshwater beach on the shores of Lake Michigan
- Belle Isle Park, Detroit, Michigan, a freshwater beach on the Detroit River between Lake St. Clair and Lake Erie
- Wollaston Beach, Quincy, Massachusetts, a marine beach in Quincy Bay
- Imperial Beach, Imperial Beach, California, a marine beach on the Pacific Ocean
- Miami Beach Park, Bowley's Quarters, Maryland, an estuarine beach on Chesapeake Bay near Middle River

EPA published the report titled *Environmental Monitoring for Public Access and Community Tracking (EMPACT) Beaches Project* in August 2005. EPA will initiate a formal review process to evaluate the study results. The Agency plans to use the results of the study, along with other recent research studies, to determine how its monitoring guidance for beach monitoring programs might be improved.

There is, for example, a range of technical and policy issues that EPA might review. These could include the depth at which samples should be collected; the time and location at which samples should be collected; other considerations, such as sampling "hot spots," the use of composite sampling, and combining sampling with site-specific predictive modeling; and other monitoring factors that states and localities should consider.

5.2 What modeling work has been conducted?

EPA has been investigating means to improve the monitoring of beach water quality and to develop strategies, including modeling, for timely notification of the public when bacterial contamination poses a risk to bathers. A few models for predicting bacteria concentrations on beaches have been

Figure 5.1. EMPACT study beaches

developed in recent years. They include statistical models that rely on readily available parameters, such as rainfall, turbidity, wind direction, and wave height.

The United States Geological Survey (USGS) has also conducted research related to beach water quality. For example, USGS has been refining monitoring methods, and conducting field sampling studies. USGS and EPA have been working to improve models to better predict water quality at beaches.

USGS has developed empirical models for beaches in Ohio and Indiana. In Ohio, USGS researchers developed beach-specific models for five Lake Erie beaches (Francy and others, 2003). At Huntington Beach, Bay Village, Ohio, predictions based on the model are being presented to the public through an Internet-based “nowcasting” system in 2006 (see http://www.ohionowcast.info/); the models for the other beaches will be presented through the nowcasting system after they are validated. In 2005, USGS scientists studied beaches in Porter and Lake Counties in Indiana and developed a mathematical model dubbed “Project SAFE” (Swim Advisory Forecast Estimate, see http://www.glsc.usgs.gov). In these types of models, sources are usually not defined explicitly because rainfall or other variables serve as surrogate source functions. Project SAFE and Nowcasting uses measurements such as rainfall, wave height, and lake turbidity to estimate *E. coli* counts and to determine when counts are high enough to threaten the health of swimmers. Because of the 24-hour time lag associated with the current technique of collecting water samples and culturing for *E. coli*, there are limitations for beach public notification decisions. Therefore, Project SAFE and Nowcasting seeks to decrease the waiting time for results by incorporating real-time information into its model prediction.

USGS began using the Project SAFE models at beaches in Gary, Indiana, during the summer of 2005. According to the SAFE protocol, each morning USGS scientists downloaded data from weather- and water-monitoring stations near or around the Burns Ditch outfall and beaches to the west. Scientists incorporated the data into the mathematical model, determined the likelihood of elevated bacteria levels, and distributed the result to beach managers in time for them to make an educated decision about keeping a beach open to swimmers, issuing an advisory that *E. coli* counts were likely elevated, or closing the beach. Similar procedures are being followed as part of the Nowcasting system in Ohio in 2006. USGS has proposed using this method for other Great Lakes beaches as well.

Less developed, at least in the area of beach bacteria predictive models, are comparatively complex hydrodynamic approaches. Based on initial and boundary conditions, these models are designed to solve the equations of motion numerically, thus predicting the fate and transport of pollutants. Although fundamentally physics-based, they also often have important empirical components to bridge gaps in knowledge or to simplify the mathematics. Such models are currently used mostly for other purposes, such as predicting the transport and fate of hydrocarbons after an oil spill. Sources are usually modeled explicitly.

Nowhere in this spectrum of existing approaches are there models that are readily applicable to new sites. Empirical models apply to specific sites, and complex numerical models generally require the services of experts and consultants to implement them.

New software called "Virtual Beach" is intended to overcome these limitations by supporting both empirical and physical approaches in an integrated application. In collaboration with USGS, EPA is designing Virtual Beach to automate the statistical analytical techniques developed by USGS. Upon collecting and compiling similar ambient data, well-motivated laypersons will be able to use Visual Beach to derive predictive statistical models for their own sites. A prototype is under development at the EPA Ecosystems Research Division in Athens, Georgia. A beta version of the Virtual Beach statistical model was distributed to selected reviewers in June 2005. Parts of the interface and statistical models were presented at the AllPI conference on Oceans and Human Health in Lansing, Michigan, April 19–20, 2005 (Ge 2005).

The goal is to develop a user-friendly application that directly or indirectly includes point and nonpoint sources of contamination, the latest bacterial decay mechanisms, real-time and Web-based ambient and atmospheric and aquatic input, and a predictive capability of up to three days to help avert potential beach closings. Upon successful completion of the first phase, similar development approaches will be used to start the second phase, the hydrodynamic modeling approach. After both the statistical and hydrodynamic approaches become available, end users will be able to select the approach most compatible with their resources and capabilities.

The suite of predictive capabilities for this software application can enhance the utility of new methodologies for analyzing indicator pathogens by identifying times that represent the highest probability of bacterial contamination. Successful use of this model will provide a means to direct timely collection of monitoring samples, strengthening the value of the short turnaround time for sampling. In addition, in some cases of known point sources of bacteria, such as wastewater treatment plant discharges, the model can be applied to help guide operational controls to help prevent resulting beach closings.

5.3 References

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