

Implementing a system for “nowcasting” bacteria levels and beach advisories

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Introduction and problem

Beach advisories and closings are made on the basis of measured concentrations of *Escherichia coli* (*E. coli*). Beach managers, U.S. Environmental Protection Agency (USEPA), and the research community have long recognized that reliance on *E. coli* is often inadequate because concentrations of *E. coli* may change drastically between the time of sampling and reporting of results (18-24 hours).

Statistical models can provide beach managers with a tool for more accurate and timely assessments of beach-water quality than the currently used methods. A statistical model typically uses easily and quickly measured surrogates, such as wave height and rainfall, to estimate *E. coli* concentrations or the probability of exceeding target concentrations and thus predict recreational water quality.

In recently published studies, the USGS developed beach-specific multiple-linear regression models (Francy and Darner, 2002; Francy and others, 2003). The probability that *E. coli* concentrations would be equal to or greater than 235 col/100 mL, the single-sample bathing-water standard, was used as the model output variable. At one Lake Erie beach, Huntington Reservation in Bay Village, Ohio (Huntington), two models were developed for which the predictive abilities appeared strong. If either Huntington model were able to perform well in predicting recreational water quality for 2 years in a row, beach managers might have enough evidence to justify using the model to direct decisions on posting beach advisories. This could be done by use of an Internet-based tool that provides beachgoers with a daily “nowcast” of recreational water quality.

Statistical models could be customized for other beaches as long as unique environmental factors are considered and tested for each beach. Lakeview and Century Beaches in Lorain County are good candidates for model development because of problems with frequent high *E. coli* concentrations at Lakeview and a suspected relation between *E. coli* and rainfall amounts at both beaches.

Goals and objectives

The goal of the study is the establishment of an Internet-based nowcasting system for presenting beach advisories based on *E. coli* concentrations.

Specific objectives to accomplish this overall goal are to:

- Test the statistical models for Huntington and compare each models’ performance with the use of the current method for assessing recreational water quality.
- Refine the Huntington models to improve their predictive abilities.

- Examine the relation between environmental and water-quality variables, such as wind direction, wave height, turbidity, and current direction, and concentrations of *E. coli* in water collected at Lakeview and Century Beaches.
- Develop statistical models for predicting *E. coli* concentrations at Lakeview and Century Beaches for future implementation of an Internet-based nowcasting system.
- Implement an Internet-based nowcasting system for presenting estimated current bacterial water quality and posting beach advisories for Huntington.

Approach

The USGS will test and refine the statistical models for Huntington and compare the models' performance with the use of the current method for assessing recreational water quality. If one of the Huntington models performs well during testing, investigators will implement an Internet-based tool (Web page) that will provide beachgoers with a daily nowcast indicating the probability that bacterial levels will exceed the bathing water standard. The Web page will also provide background information on the science of beach monitoring and supporting information on the posted advisories. For Century and Lakeview beaches, this study will be the first step towards developing an Internet-based nowcasting system based on statistical models.

Samples will be collected and data will be compiled at Huntington, Century, and Lakeview beaches for predictive modeling during the recreational seasons of 2004, 2005, and 2006. Data include:

- Measurements of water turbidity, temperature, and specific conductance
- Measurements of rainfall amounts, wastewater treatment plant overflows, metered outfalls, tributary inputs, number of birds, wave height, wind speed and direction, and current directions
- Concentrations of *E. coli* in water

The USGS will use multiple linear regression (MLR) to predict recreational water quality from explanatory variables. The output from the model(s) will be the probability that the true value will exceed the recreational water-quality standard. The USGS will then develop a computer program for each beach investigated that can be used by beach managers to compute the probability of exceeding the bathing-water standard on the basis of current conditions.

For Huntington, this information will be disseminated through an Internet-based nowcasting system, maintained by the Cuyahoga County Board of Health with assistance from the USGS. For Century and Lakeview, the model will have to be tested in subsequent years before implementing an Internet-based nowcasting system.

Final results will be presented in 2005 in a journal article describing the development of models at Huntington, Lakeview, and Century and results of testing at Huntington.