Modeling and source-tracking tools for understanding fecal contamination and predicting recreational water quality at Ohio beaches

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Introduction and problem

The level of fecal contamination of recreational waters is assessed on the basis of measured concentrations of *Escherichia coli* (*E. coli*). Measurements of *E. coli*, however, take at least 18 hours for results, and water quality may change drastically during this time. In addition, collecting one or two samples for *E. coli*, as is commonly done, does not provide information on the sources of fecal contamination.

New technologies are needed for more rapid assessments of recreational water quality and for identifying sources of contamination. Statistical models may provide beach managers with a tool to make accurate and timely assessments of recreational-water quality using environmental or water-quality factors that are easily and quickly measured. Models may be developed using multiple linear regression (MLR) and artificial neural network (ANN) techniques. Source-tracking methods include methods that monitor directly for indicators of human and (or) animal waste, such as identifying the genotype of F-specific coliphage or the presence of human enteric viruses. Antibiotic resistance analysis (ARA) is a source-tracking method that uses patterns based on different levels of resistance by bacteria to antibiotics. The assumption for ARA is that the use of antibiotics in humans and domestic animals and lack of use in wild animals allows for different resistance patterns and discrimination of *E. coli* from these hosts. Sampling can also be done to identify if a source of *E. coli* is the storage in lake-bottom sediments or subsurface sediments from near the swash zone. (The swash zone is the zone of the shoreline that is constantly washed by waves or tides.)

The proposed work will be done at three Lake Erie beaches. Models developed for Edgewater and Villa Angela, in Cleveland, during a previous study need further refinement and testing. At a third beach, Lakeshore Park in Ashtabula, beach advisories based on elevated *E. coli* concentrations are often posted. The sources of *E. coli* at Edgewater and Lakeshore are largely unknown. The application of source-tracking techniques may help in identifying sources as well as enhancing the development of predictive models.

Goals and objectives

The overall goal of the proposed work is to improve the science of recreational water-quality monitoring and prediction. Specific objectives to accomplish this overall goal are to:

- Refine and test existing MLR models for Edgewater and Villa Angela, develop a new model for Lakeshore, and investigate the use of ANNs for predicting *E. coli* concentrations at all three beaches.

- Identify the spatial distribution of *E. coli* at Edgewater and Lakeshore so that possible sources of fecal contamination can be identified.
- Test the use of source-tracking techniques, such as identification of human enteric viruses and genotyping of F-specific coliphage, to determine whether humans and (or) animals are significant sources of fecal contamination at Edgewater and Lakeshore.
- Determine the relations between concentrations of *E. coli* in sediments and interstitial waters collected from near the swash zone to those in bathing waters at Edgewater.

Approach

Two types of studies are proposed to address project objectives. Routine studies involve the daily collection and analysis of water samples for *E. coli* and the measurement of explanatory variables for model refinement, development, and testing. Periodic studies are done at Edgewater and Lakeshore and involve the periodic sampling of the following:

- Lake-bottom sediment samples for *E. coli*,
- Lake water samples for *E. coli* concentrations and ARA, human enteric viruses, and F-specific coliphage genotyping,
- Interstitial water and subsurface sediments from near the swash zone for *E. coli* concentrations and ARA and for F-specific coliphage genotyping.

The results of this investigation will be published as two journal articles in 2006 and presented at scientific and public meetings.