

The Ozaukee County Public Health Department used EPA's Virtual Beach to predict real-time water quality at a high-priority Lake Michigan beach in the City of Port Washington. Virtual Beach is a free decision-support tool that enables local beach managers to build and operate multivariate statistical "nowcast" models, which have been shown to be more accurate than standard water quality monitoring techniques.



## Ozaukee County, Wisconsin

Ozaukee County is home to several swimming beaches on Lake Michigan's southwestern shore, including five high priority beaches. Across the Great Lakes, high priority beaches are [monitored](#) regularly for the fecal indicator bacteria *E. coli* in accordance with the federal [BEACH Act](#). The presence of *E. coli* indicates the possibility that pathogens are present. When concentrations exceed 235 colony forming units (CFU) per 100 mL, beach managers post swim advisories. In Wisconsin, concentrations over 1000 CFU/100 mL result in beach closures.

Standard water quality monitoring entails collecting samples at the beach, transporting them to a lab, and culturing for *E. coli*. Typically, this process takes 24 hours, so that managers base their decisions on whether or not to post advisories on data that is a day old (or older, if samples are collected less than seven days a week). Numerous studies have shown that this so-called "persistence model" results in frequent Type I errors (false exceedances) and Type II errors (false non-exceedances). This, in turn, leads in increased exposure to water borne pathogens, as well as unnecessary advisories and closures.

Multivariate statistical models have been shown to provide more timely and more accurate predictions of recreational water quality at Great Lakes beaches. These models "nowcast" *E. coli* concentrations in real-time, based on current measurements of contributing factors, such as antecedent rainfall, wave height, water temperature, wind speed and direction, nearshore currents, and gauged flow of streams discharging at or near the beach.

Until recently, the widespread adoption of this method has been limited by the absence of a free, user-friendly tool for building, evaluating, and implementing nowcast models. Faced with limited resources, local beach managers are unlikely to have the combination of staff time, modeling expertise, and/or commercial software necessary to successfully build and deploy nowcast models. To fill this void, [EPA ORD/NERL/ERD](#) developed Virtual Beach, which enables beach managers to build and refine models to predict pathogen indicator concentrations in real-time, based on meteorological, onshore, and near shore conditions.

During the spring and summer of 2009, staff from the [Ozaukee County Public Health Department](#) and the [Wisconsin Department of Natural Resources Bureau of Science Services](#) partnered to develop an operational nowcast model at Upper Lake Park Beach

Standard lab-based monitoring of recreational water quality frequently provides incorrect estimates of current pathogen indicator concentrations. Local beach managers need more timely and accurate information when deciding whether to post swim advisories or beach closures. To date, rapid lab-based methods and real-time predictive models have been beyond the resources and technical capacity of local beach managers.

Ozaukee County, Wisconsin is using EPA's Virtual Beach tool to build and operate real-time water quality "nowcast" models that are more accurate than standard monitoring and less costly than rapid, lab-based methods.

in the City of Port Washington, using Virtual Beach. Development of the model took approximately 40 hours of combined staff time, using data collected during the 2007 and 2008 beach seasons through regular beach monitoring and [sanitary survey](#) work. Data included wave height, turbidity, 24 and 48 hour rainfall, stream flow, water and air temperature, and the previous day's lab results on *E. coli*.

Once built, the model was used to nowcast daily conditions. Running the model took approximately 5 minutes per day as part of routine monitoring and sanitary survey work. County staff entered daily data into the model concurrent to their routine reporting on the [Wisconsin Beach Health website](#), which is operated by the [USGS Wisconsin Water Science Center](#). Model results (i.e., whether or not to post an advisory) were also posted on the Beach Health site for public notification.

In addition to the fact that local staff were able to run the model without interfering with their normal activities, the model proved to be highly accurate, with an R-square value of 0.63, a significant reduction in Type I and Type II errors relative to the "persistence model" during the 2007-2008 model-building period, no Type I errors during the 2009 nowcast, and a mean absolute error of just 19 CFU/100 mL (untransformed) in 2009. The absolute error is low in part because observed and predicted values were low in 2009 (i.e., no actual exceedances); however, a visual inspection of the nowcast performance confirms that the model was extremely sensitive to small-scale fluctuations in *E. coli*.

Real-world testing of Virtual Beach in 2009 led to a number of practical suggestions that are being incorporated into the Virtual Beach version 2.0, which will be released in 2010. The enhanced software will make operational nowcasting easier, and contribute to a wider technology transfer across the Great Lakes.

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