

Prepared in cooperation with the
U.S. Environmental Protection Agency

Developing and Implementing Predictive Models for Estimating Recreational Water Quality at Great Lakes Beaches

Real-time assessments can be done by means of predictive models at recreational beaches. Predictive models use easily measured environmental and water-quality variables, such as lake levels, rainfall amounts and water clarity (turbidity), to estimate current water-quality conditions affecting fecal-indicator bacteria concentration.

The Great Lakes Restoration initiative (GLRI) template #77 (Beach Recreation Water Quality) in cooperation with 23 local and state agencies expanded the use of predictive modeling at 45 beaches throughout the Great Lakes (fig 1). Local agencies measure fecal-indicator bacteria such as *Escherichia coli* (*E. coli*) along with

easily obtained environmental variables used as surrogates to estimate concentrations of fecal-indicator bacteria through a predictive modeling approach. The predictive modeling is being developed by the use of linear regression and/or partial least-squares techniques. The models use software developed by the U.S. Environmental Protection Agency

known as “Virtual Beach”. Each beach model is based on a combination of explanatory variables, most commonly, turbidity, day-of-year, change in lake level over 24 hours, rainfall, wave height, and wind direction and speed. Forty-two predictive models were validated in this study where overall correct responses are greater or equal to 80 percent of the

Beach Sampling Sites Throughout the Great Lakes

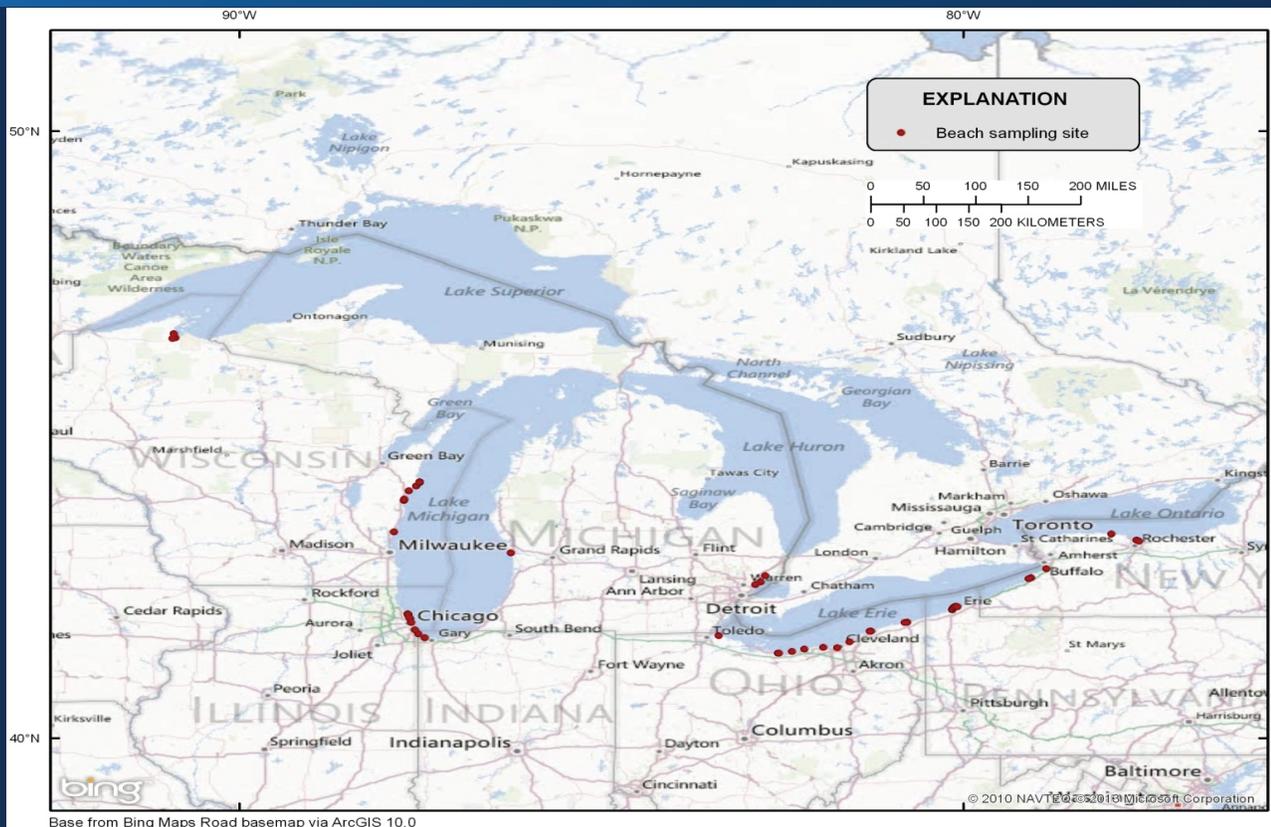
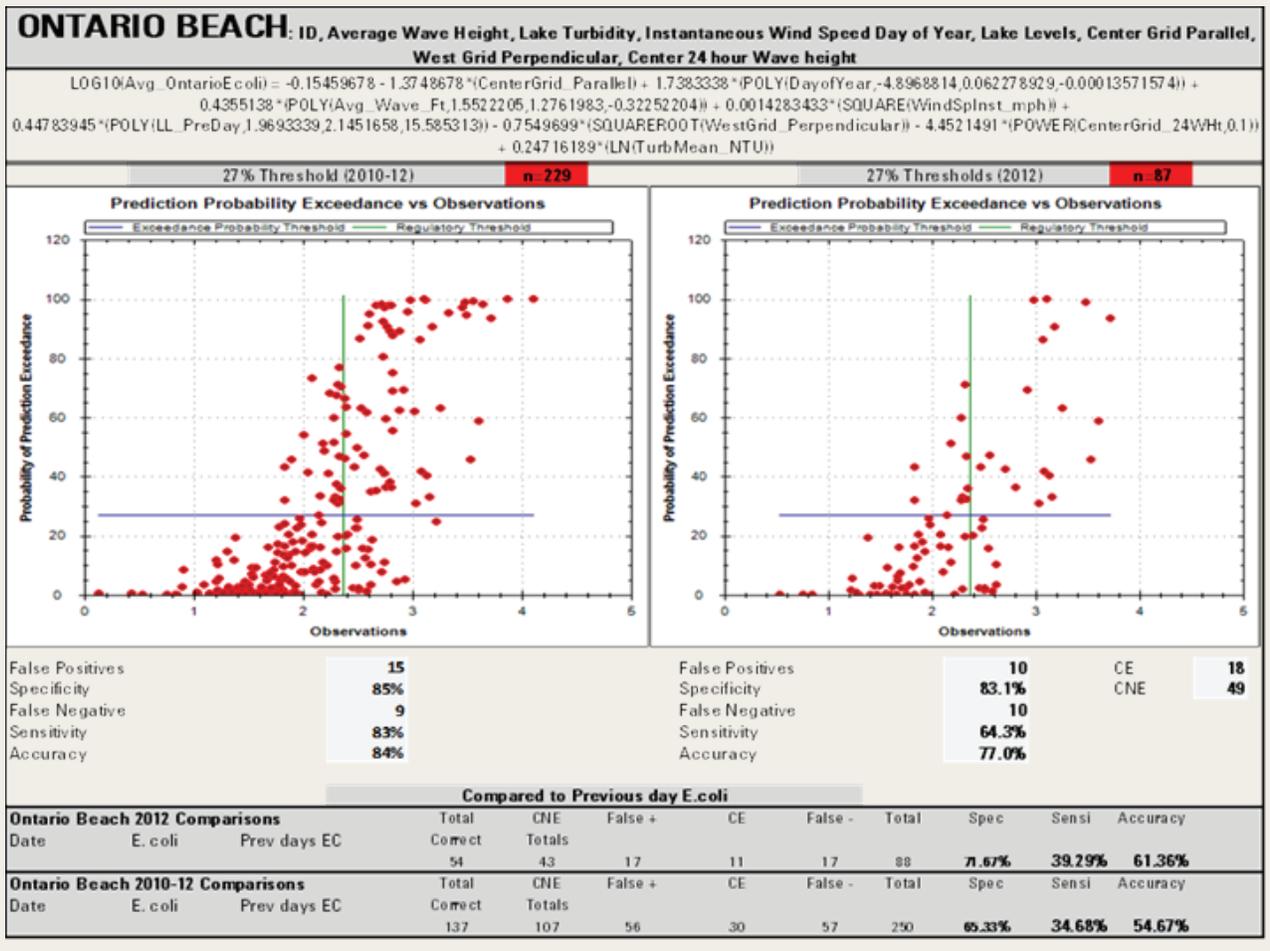


Figure 1. Beach site locations throughout the Great Lakes where predictive models have been developed to estimate water quality.

Modeled Parameters at Ontario Beach in Monroe County, New York



Above illustration of modeled parameters at Ontario Beach in Monroe County, New York. Including comparison of predictive modeled data from development years 2010-12 and validation year 2012 based on a threshold of 27 percent threshold of predicted exceedances. Also, provided is the persistence model statistics which compares persistence methods to predictive model methods over the same periods of time.

percentage of exceedance of the EPA bathing-water standard of 235 colony forming units per 100 milliliters.

Model Definitions:

- Persistence models—use the previous day’s *E. coli* concentration to estimate the current day’s *E. coli* concentration.
- Predictive models— are statistical models that use environmental and water-quality variables to estimate the probability that the State standard will be exceeded or to directly estimate concentrations of *E. coli*. (Francy and others, 2013)

Measures of model performance include the following:

- The overall percentage of correct responses (exceedances and nonexceedances) that are predicted by the predictive or persistence model.
- The sensitivity of the model; that is, the percentage of exceedances of the bathing-water standard that are correctly predicted by the predictive or persistence model.
- The specificity of the model; that is, the percentage of nonexceedances of the bathing-water standard that are correctly predicted by the predictive or persistence model. (Francy and others, 2013)

Reports

Francy, D.S., Brady, A.M.G., Carvin, R.B.,

Corsi, S.R., Fuller, L.M., Harrison, J.H., Hayhurst, B.A., Lant, J., Nevers, M.B., Terrio, P.J., and Zimmerman, T.M., 2013, Developing and implementing the use of predictive models for estimating water quality at Great Lakes beaches: U.S. Geological Survey Scientific Investigations Report 2013–5XXX, xx p.

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