

## Predictive Models for Microbial Water Quality: A Selection of Useful References

Compiled by **Adam C. Mednick**, Bureau of Science Services

Presented below is a list of recent journal articles and technical documents that discuss statistical models for predicting beach water quality. These articles provide a scientific foundation for the development and testing of predictive beach water quality models.

Boehm, A.B., R.L. Whitman, M.B. Nevers, and B. Weisberg. 2007. Nowcasting recreational water quality. Pp. 179-210 In L.J. Wymer (ed.). *Statistical Framework for Recreational Water Quality Criteria and Monitoring*. New York, Wiley.

Crowther, J., D. Kay, and M.D. Wyer. 2001. Relationships between microbial water quality and environmental conditions in coastal recreational waters: The Fylde Coast, UK. *Water Research* 35(17):4029-4038.

Eleria, A. and R.M. Vogel. 2005. Predicting fecal coliform bacteria levels in the Charles River, Massachusetts. *Journal of the American Water Resources Association* 41(5):1195-1209

Francy, D.S. 2009. Use of predictive models and rapid methods to nowcast bacteria levels at coastal beaches. *Aquatic Ecosystem Health and Management* 12(2):177-182.

Francy, D. S., R. A. Darner, and E.E. Bertke. 2006. Models for predicting recreational water quality at Lake Erie beaches. Scientific Investigations Report. Reston, VA: U.S. Geological Survey. 13 pp.

Francy, D.S. and R.A. Darner. 2006. Procedures for developing models to predict exceedances of recreational water-quality standards at coastal beaches. Techniques and Methods 6–B5. Reston, VA: U.S. Geological Survey. 34 pp.

Francy, D.S., E.E. Bertke, and R.A. Darner. 2009. Testing and refining the Ohio nowcast at two Lake Erie beaches—2008. Open File Report 2009–1066. Reston, VA: U.S. Geological Survey. 20 pp.

Francy, D.S. and R.A. Darner. 2007. Nowcasting beach advisories at Ohio Lake Erie beaches. Open File Report 2007-1427. Reston, VA: U.S. Geological Survey. 13 pp.

Francy, D.S., A.M. Gifford, and R.A. Darner. 2003. *Escherichia coli* at Ohio bathing beaches—Distribution, sources, wastewater indicators, and predictive modeling. Water-Resources Investigations Report 02-4285. Reston, VA: U.S. Geological Survey. 47 pp.

Frick, W.E., Z. Ge, and R. Zepp. 2008. Nowcasting and forecasting concentrations of biological contaminants at beaches: A feasibility and case study. *Environmental Science and Technology* 42(13):4818-4824.

Ge, Z. and W.E. Frick. 2007. Some statistical issues related to multiple linear regression modeling of beach bacteria concentrations. *Environmental Research* 103(3):358-364.

Harris, E.L., R.A. Falconer, B. Lin. 2004. Modelling hydroenvironmental and health risk assessment parameters along the South Wales Coast. *Journal of Environmental Management* 73(1):61-70.

Harris, E., R.A. Falconer, D. Kay, and C. Stapleton. 2002. Development of a modelling tool to quantify faecal indicator levels in Cardiff Bay. *Proceedings of the Institution of Civil Engineers: Water and Maritime Engineering* 154(2):129-135.

- He, L.M. and Z.L. He. 2008. Water quality prediction of marine recreational beaches receiving watershed baseflow and stormwater runoff in southern California, USA. *Water Research* 42(10-11): 2563-2573.
- Heberger, M.G., J.L. Durant, K.A. Oriel, P.H. Kirshen, and L. Minardi. 2008. Combining real-time bacteria models and uncertainty analysis for establishing health advisories for recreational waters. *Journal of Water Resources Planning and Management* 134(1): 73-82.
- Hellweger, F.L. and P. Masopust. 2008. Investigating the fate and transport of *Escherichia coli* in the Charles River, Boston, using high-resolution observation and modeling. *Journal of the American Water Resources Association* 44(2): 509-522.
- Hou, D., S.J.M. Rabinovici, and A.B. Boehm. 2006. Enterococci predictions from partial least squares regression models in conjunction with a single-sample standard improve the efficacy of beach management advisories. *Environmental Science and Technology* 40(6): 1737-1743.
- Kashefipour, S.M., B. Lin, E. Harris, and R.A. Falconer. 2002. Hydro-environmental modelling for bathing water compliance of an estuarine basin. *Water Research* 36(7): 1854-1868.
- Kashefipour, S.M., B. Lin, and R.A. Falconer. 2006. Modelling the fate of faecal indicators in a coastal basin. *Water Research* 40(7): 1413-1425.
- Kay, D., M. Wyer, J. Crowther, C. Stapleton, M. Bradford, A. McDonald, J. Greaves, C. Francis, and J. Watkins. 2005. Predicting faecal indicator fluxes using digital land use data in the UK's sentinel Water Framework Directive catchment: The Ribble study. *Water Research* 39(16): 3967-3981.
- Kelsey, H., D.E. Porter, and G. Scott, M. Neet, and D. White. 2004. Using geographic information systems and regression analysis to evaluate relationships between land use and fecal coliform bacterial pollution. *Journal of Experimental Marine Biology and Ecology* 298(2): 197-209.
- Lin, B., M. Syed, and R.A. Falconer. 2008. Predicting faecal indicator levels in estuarine receiving waters - An integrated hydrodynamic and ANN modelling approach. *Environmental Modelling and Software* 23(6): 729-740.
- Liu, L., M.S. Phanikumar, S.L. Molloy, R.L. Whitman, D.A. Shively, M.B. Nevers, D.J. Schwab, and J.B. Rose. 2006. Modeling the transport and inactivation of *E. coli* and enterococci in the near-shore region of Lake Michigan. *Environmental Science and Technology* 40(16): 5022-5028.
- McPhail, C.D. and R.T. Stidson. 2009. Bathing water signage and predictive water quality models in Scotland. *Aquatic Ecosystem Health and Management* 12(2): 183-186.
- Nevers, M.B. and R.L. Whitman. 2005. Nowcast modeling of *Escherichia coli* concentrations at multiple urban beaches of Southern Lake Michigan. *Water Research* 39(20): 5250-5260.
- Nevers, M.B. and R.L. Whitman. 2008. Coastal strategies to predict *Escherichia coli* concentrations for beaches along a 35 km stretch of Southern Lake Michigan. *Environmental Science and Technology* 42(12): 4454-4460.
- Nevers, M.B., D.A. Shively, G.T. Kleinheinz, C.M. McDermott, W. Schuster, V. Chomeau, and R.L. Whitman. 2009. Geographic relatedness and predictability of *E. coli* along a peninsular beach complex of Lake Michigan. *Journal of Environmental Quality* 38(6): 2357-2364.
- Nevers, M.B., R.L. Whitman, W.E. Frick, and Z. Ge. 2007. Interaction and influence of two creeks on *Escherichia coli* concentrations of nearby beaches: Exploration of predictability and mechanisms. *Journal of Environmental Quality* 36(5): 1338-1345.

- Olyphant, G.A.. 2005. Statistical basis for predicting the need for bacterially induced beach closures: Emergence of a paradigm? *Water Research* 39(20): 4953-4960.
- Olyphant, G.A. and R.L. Whitman. 2004. Elements of a predictive model for determining beach closures on a real time basis: The case of 63rd Street Beach Chicago. *Environmental Monitoring and Assessment* 98(1): 175-190.
- Olyphant, G.A., J. Thomas, R.L. Whitman, and D. Harper. 2003. Characterization and statistical modeling of bacterial (*Escherichia coli*) outflows from watersheds that discharge into southern Lake Michigan. *Environmental Monitoring and Assessment* 81(1): 289-300.
- Parkhurst, D.F., K.P. Brenner, A.P. Dufour, and L.J. Wymer. 2005. Indicator bacteria at five swimming beaches—Analysis using random forests. *Water Research* 39(7): 1354-1360.
- Schnauder, I., B. Bockelmann-Evans, and B. Lin. 2007. Modelling faecal bacteria pathways in receiving waters. *Proceedings of the Institution of Civil Engineers: Maritime Engineering* 160(4): 143-153.
- Siewicki, T.C., T. Pullaro, W. Pan, S. McDaniel, R. Glenn, and J. Stewart. 2007. Models of total and presumed wildlife sources of fecal coliform bacteria in coastal ponds. *Journal of Environmental Management* 82(1): 120-132.
- Stretch, D. and D. Mardon. 2005. A simplified model of pathogenic pollution for managing beaches. *Water South Africa* 31(1): 47-52.
- U.S. Environmental Protection Agency. 1999. Review of potential modeling tools and approaches to support the BEACH program. EPA 823-R-99-002. Washington, DC: U.S. Environmental Protection Agency. 42 pp.
- Whitman, R.L., M.B. Nevers, and P.J. Gerovac. 1999. Interaction of ambient conditions and fecal coliform bacteria in Southern Lake Michigan beach waters: Monitoring program implications. *Natural Areas Journal* 19(2): 166-171.

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**Bureau of Science Services  
Wisconsin Department of Natural Resources  
P.O. Box 7921  
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