Enhancing Great Lakes Beach Recreational Water Quality Decision Making for the Great Lakes Restoration Initiative

This project is funded by the Great Lakes Restoration Initiative (GLRI), an interagency program that addresses the most significant environmental problems in the Great Lakes ecosystem. Results from U.S. Geological Survey (USGS) scientific studies and monitoring are helping guide the restoration effort. The GLRI is made up of five focus areas that address these issues:

- Cleaning up toxic substances and areas of concern
- Combating invasive species
- Promoting nearshore health by protecting watersheds from polluted runoff
- Restoring and protecting habitats and wildlife
- Tracking progress and working strategically with partners

More information is available on the USGS GLRI Web page (*http://cida.usgs.gov/glri/*).

Project Background

View of Chicago from Indiana Dunes National Lakeshore

Beach closures, resulting from poor water quality, are not uncommon around the Great Lakes, where more than 500 beaches (along nearly 11,000 miles of coastline) are routinely used.

Escherichia coli (*E. coli*) and enterococci are fecal indicator bacteria (FIB) that may indicate the presence of human disease-causing pathogens that originate from both human and animal sources. If levels of these bacteria become elevated, beaches are closed to swimming or advisories are issued. This not only impacts the public but also the economies of the coastal areas affected. In order to make accurate decisions about water quality that maintain public confidence, beach managers need reliable, science-based information.

Beach health signage

USGS scientists are developing rapid water quality assessment approaches and decision-making tools that provide timely and accurate information to beach managers and the public on daily swimming conditions and beach health. On-the-ground science is also being conducted to find sources of pollution and the environmental conditions that may create a situation where unhealthy bacteria or viruses can survive and pose a threat to public health.

Objectives and Approach

Objective 1: Real-time assessments

Expand the use of real-time (nowcast) systems and rapid analytical methods to more beaches around the Great Lakes and work to improve existing beach health predictive models.

Sampling water quality

Approach

- Modeling workgroups will improve and refine predictive modeling capabilities.
- Researchers will work with the City of Chicago to develop, implement, and refine a functioning monitoring program based on empirical predictive modeling.
  - Once models have been refined, modeling activities will be expanded to more beaches.
  - In cooperation with the City, USGS will continue to assist in improving the application and expansion of predictive models for these beaches, which will provide insight for model validation and calibration and potentially the identification of contamination sources.

Acoustic Doppler Current Profiler deployment near Ogden Dunes

GLRI 77-2013

Objective 2: Data analysis and interpretation

USGS researchers will evaluate existing monitoring data in light of emerging techniques for improving monitoring accuracy. Scientists will examine the potential for new methods of beach monitoring to improve public health protection by associating health studies with monitoring data.

Approach

- Initially, USGS staff will work to integrate all beach monitoring data and other data (e.g., meteorological) from selected Great Lakes beaches into a single database.
- Regional models will be developed that extend assessments of extended shorelines. These will provide insight for large-scale, background fluctuations in bacteria concentrations, allowing us to identify potential pollution inputs at high contamination locations.

Analyzing beach monitoring data

Objective 3: Understanding coastal processes affecting nearshore water quality

The purpose of these studies is to characterize the transfer of fecal indicators, pathogens, and additional bacterial, molecular, and/or chemical indicators of non-point sources between shoreline or sediment sources and swimming water. The pathways and mechanisms by which these transfers occur will be explored through surveys, empirical analysis, and mechanistic modeling.

Approach

- Improve the understanding of potential sources of FIB to beach sands, pore, and lake water.
  - Hydrodynamic models that describe the movement of bacteria by lake currents, waves, and wind will be developed.
- Determine the relation between different environmental conditions and sediment dynamics.
  - The interaction of lake waves and shoreline sediment will be examined to determine the direction and rate of movement of bacteria.

Deploying current profiling and water quality instruments

Recent Highlights

A website developed with the City of Chicago provides real-time information for lake and weather conditions at several Chicago beaches during the summer. These data are used in the predictive modeling monitoring program (http://v4.wqdata.com/webdblink/chicagopark.php).

Several recent publications have examined the public health protection afforded by the use of emerging technologies for beach monitoring:

Nevers, M. B., M. N. Byappanahalli, and R. L. Whitman. 2013. Choices in Recreational Water Quality Monitoring: New Opportunities and Health Risk Trade-offs. Environmental Science & Technology 47:3073-3081.

Nevers, M. B. and R. L. Whitman. 2011. Efficacy of monitoring and empirical predictive modeling at improving public health protection at Chicago beaches. Water Research 45:1659-1668.

Nevers, M. B. and R. L. Whitman. 2011. Beach Monitoring Criteria: Reading the Fine Print. Environmental Science & Technology 45:10315-10321.

Recent publications have also described the hydrodynamic processes influencing nearshore water quality:

Ge, Z., R. L. Whitman, M. B. Nevers, M. S. Phanikumar, and M. N. Byappanahalli. 2012. Evaluating the role of an embayed beach as a reservoir and a net source of fecal contamination. Limnology and Oceanography 57:362-381.

Ge, Z., R. L. Whitman, M. B. Nevers, and M. S. Phanikumar. 2012. Wave-induced mass transport affects daily Escherichia coli fluctuations in nearshore water. Environmental Science & Technology 46:2204-2211.

Ge, Z., M. B. Nevers, D. J. Schwab, and R. L. Whitman. 2010. Coastal loading and transport of Escherichia coli at an embayed beach in Lake Michigan. Environmental Science & Technology 44:6731-6737.

The economic loss to a community from a swim closure is estimated to range from $1,274 to $37,030/day (Coastal Health Strategy Team Report Draft, Great Lakes Regional Collaboration, 2005).

Outcomes

Empirical predictive models will provide real-time estimates of water quality that will, in turn, protect millions of Chicago beach visitors from potential exposure to harmful pathogens.

USGS findings will help in developing a conceptual understanding of large-scale lake processes. By deciphering the components of bacteria fluctuations, restoration efforts can be targeted more efficiently to improve water quality.

Scientists will have a better understanding of how foreshore and very nearshore processes contribute to bacteria contamination of recreational waters.

Enjoying an open beach

Great Lakes RESTORATION

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