Monitoring & analysis of *Escherichia coli* in the nearshore waters of Lake St. Clair

Andrea L. Paine[1], Alicia A. Ritzenthaler[2], Eva L. Kramer[2], Andrew D. Gronewold[3]

[1]Undergraduate Research Opportunity Program (UROP), University of Michigan, Ann Arbor, MI, USA

[2] Cooperative Institute for Limnology and Ecosystems Research, University of Michigan, Ann Arbor, MI, USA

[3]National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, Ann Arbor, MI, USA

Introduction & Background

Water monitoring, analysis, and forecasting systems are necessary in densely populated, urban environments, such as the area near Harrison Township on Lake St. Clair (**Figure 2: A & C**), to ensure the ambient and anthropologic variables affecting the near-shore hydrography are identified and effective public health initiatives are developed. The water, beaches, and people in this area of southwest Michigan are under threat of high concentrations of *Escherichia coli* (*E. coli*), which can pose risks to human health.[1-2] Lake St. Clair, a vital part of the Great Lakes economy and ecosystem, is used for recreational purposes such as fishing, boating, swimming, as well as for drinking water and commercial navigation. With constant recreational use during the summer months, a forecasting system to predict these high levels of bacteria would prevent the adverse health effects caused by *E. coli*.[3] With over six million U.S. and Canadian residents benefitting from Lake St. Clair's resources, these efforts are needed to ensure the safety of these public waters.[4] With ample variables affecting the water quality along the Lake St. Clair shoreline, there is a need for a more extensive and complete understanding of the near shore aquatic system.

Objectives

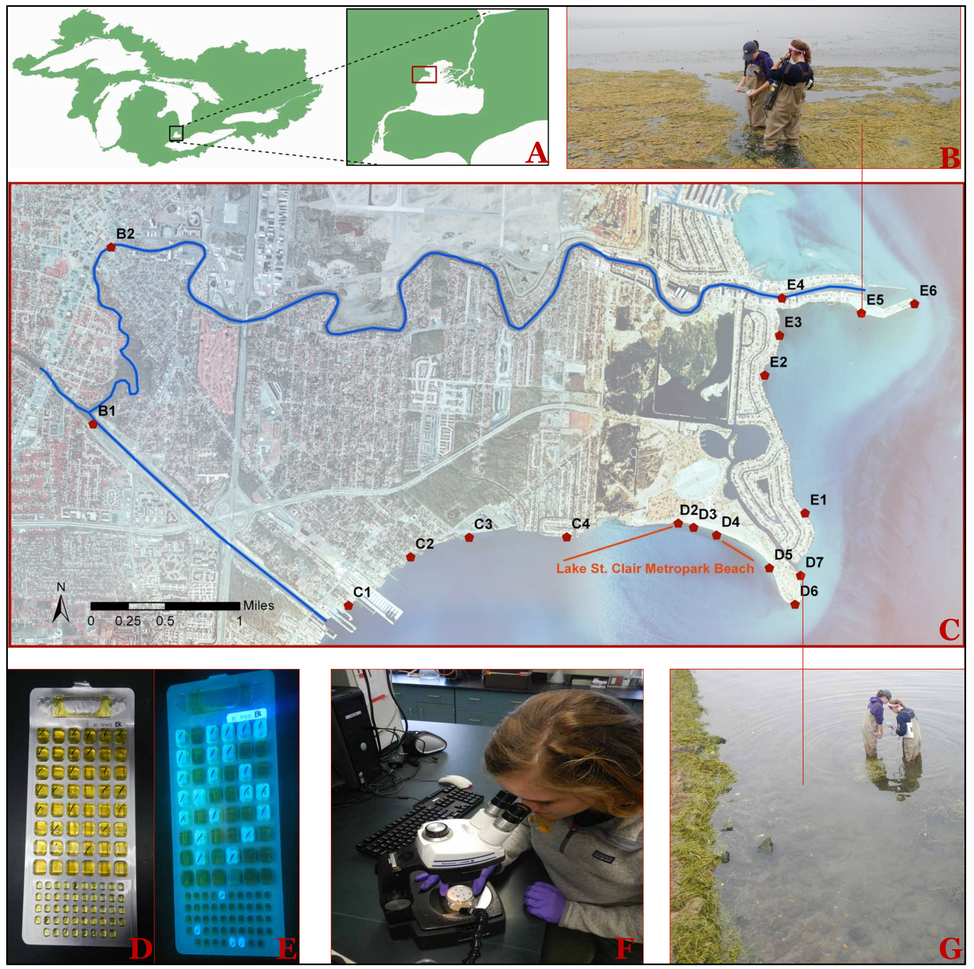
1. Develop a better understanding of the Clinton River Watershed and the nearshore water system of Lake St. Clair.
2. Improve public health and management decisions associated with beach access in the Lake St. Clair area.
3. Determine *E. Coli* fate and transport in the watershed, as well as variables affecting these dynamics.
4. Create hydrodynamic and hydrologic models (**Figure 3**) to illustrate the dynamics of *E. coli* in the area of study, leading to the development of an operational forecasting system.

Methods

Once a week from April through December, water samples are collected from 18 different sample sites (**Figure 2: C**) along the northwest shore of Lake St. Clair. At each site, 250 mL of water is collected. Temperature and conductivity is also recorded at each site. Upon returning to the laboratory, the samples are refrigerated until they are analyzed for *E. coli* the following day using the IDEXX Colilert (**Figure 2: D & E**) and membrane filtration methods. Once the samples are prepared following the standard procedures of each method, they are incubated at around 35 degrees Celsius for 24 hours. After the 24 hours of incubation, results are recorded (**Figure 2: F**).

Results & Conclusions

Upon the completion of the 2012 field season, the data collected at each of the 18 sites was plotted and assimilated into hydrodynamic models. **Figure 1** illustrates the variability in the concentration of *E. coli* along the shoreline. The public health department only collects samples from D2-D4 and these are often seen by the general public as a representation of the quality of the entire near shore water. This study reveals that this assumption is not necessarily accurate. More specifically, **Figure 1** reveals that while a majority of the *E. coli* levels lie below the state determined guidelines, there also exists high levels of unpredictable variability at some sites. Furthermore, this research reveals the need for a more effective and in-depth public monitoring system for Great Lakes beaches that uses hydrologic-hydrodynamic models (**Figure 3**) for water quality forecasting. With a diversity of variables affecting the near shore water quality, such a monitoring system would depict the varying *E. coli* levels at each site, leading to a healthier beach environment and a more informed public. This project is adopting more sampling sites for the 2013 field season and furthering the development of the forecasting system.



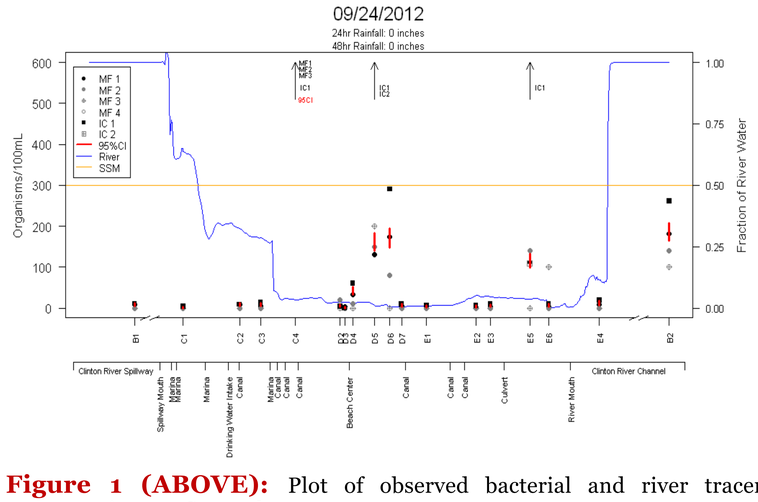
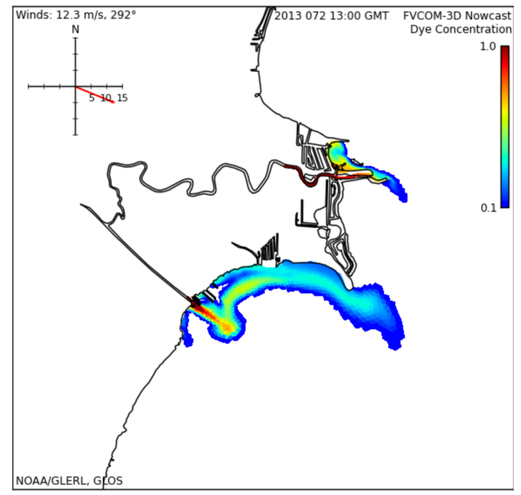


Figure 1 (ABOVE): Plot of observed bacterial and river tracer concentrations on September 24, 2012.

Figure 2: ⟵ Location map of the Clinton River, nearshore Lake St. Clair, and the 18 monitoring locations at which water quality samples were collected. Also shown are photos of the routine water sample collection and lab analysis.

Figure 3: ⟶ Model simulated tracer of the Clinton River plume representing the relative distribution of Clinton River water as it enters and mixes with Lake St. Clair.



Acknowledgements & References

This research is funded by the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory, the Cooperative Institute for Limnology and Ecosystems Research, the Great Lakes Observing System, the Great Lakes Restoration Initiative, and the Undergraduate Research Opportunity Program. Also, special thanks to Eric Anderson for the hydrodynamic modeling and to the residents of Lake St. Clair for private beach access.

[1] Cabelli, V. J. (1989). Swimming-associated illness and recreational water quality criteria. Water Science and Technology 21(2), 13-21.

[2] Wade, T.J., Pai, N., Eisenberg, J.N.S., Colford Jr., J.M. (2003). Do US EPA water guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis. Environmental Health Perspectives 111(8), 1102–1109.

[3] Edsall, T. A., Manny, B. A., and Raphael, C. N. (1988). The St. Clair River and Lake St. Clair, Michigan: an ecological profile. US Fish and Wildlife Service Biological Report 85(7.3), 130.

[4] United States Army Corp of Engineers, Detroit District. (2005). St. Clair River and Lake St. Clair Comprehensive Management Plan, June 2004, 1-22.