



Update on EPA's Research for the Development of Recreational Water Quality Criteria



GLBA Annual Conference
October 20, 2010



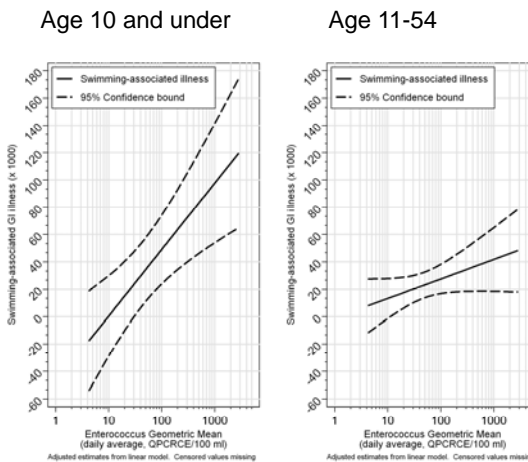
Epidemiology Studies

- 4 Freshwater studies conducted in Great Lakes (2003-2004)
- Studies conducted at 3 Marine locations (2005-2007)
- Study conducted at a marine beach impacted by urban runoff in a temperate region (2009)
- Study conducted in a tropical region (2009)



NEEAR Water Study: Results

- Seven beaches
 - Treated sewage impact
- *Enterococcus* qPCR CE
 - Associated with gastrointestinal illness among swimmers
- Some evidence of high “sensitivity” among children in freshwater study
 - Preliminary Results: *Enterococcus* qPCR CE, *Bacteroidales*, qPCR CE showed associations with GI illness



Wade 2008

3



Urban Runoff Epi Study at Surfside, SC

- Study Data Collection (29 days)
 - 11,159 interviews from 5,205 households
 - 530 water samples collected (at beach)
- Water Quality (*Enterococcus*)
 - Good water quality
 - No days exceeded current criteria for marine water (not expected)
- Status: EPA report being externally peer reviewed
- Preliminary Results:
 - Positive but statistically insignificant associations with *Enterococcus* CFU, Enterococcus qPCR CCE and GI illness



Figure 2: Surfside Beach contaminated sample locations



Figure 7: Schematic of Surfside Beach



Tropical Waters Study at Boquerón, PR

- Study Data Collection (26 days)
 - 15,726 interviews from 6,611 households
 - 600 water samples collected (beach sites)
- Water Quality (*Enterococcus*)
 - Good water quality
 - High proportion of samples (~30%) showed problems with the internal positive control assay
 - Currently collecting additional samples and investigating reasons for qPCR interference
- Status: EPA report being externally peer reviewed
- Preliminary Results:
 - Good water quality, low exposure range, sample interference issue with qPCR
 - qPCR/health association-difficult to interpret due to the sample interference and low detection of indicator bacteria



Figure 2d. Boquerón Beach contaminated sampling location (yellow pins)



qPCR Signal Fate and Transport

Objective: To evaluate how well molecular and culture-based indicators perform as surrogates for the pathogens

Approach: measure pathogen and fecal indicator levels in untreated and treated wastewater and persistence in discharged effluents

Status/Results*

- Draft Report currently undergoing external peer review
- Enterococci qPCR measurements persisted more than culture through chlorine and UV disinfection.
- Both qPCR and culture measurements degraded at similar rates in discharged effluents.
- Pathogens were not found consistently or at sufficient levels to assess persistence

6

*subject to change, based on external peer review comments and revision



Sample Holding Time Study

- **Short-term holding time:** fresh refrigerated samples were held and analyzed at 24 and 48 hours
- **Long-term holding time:** frozen samples were held and analyzed at 6, 12, and 24 months
- **Archived sample stability:** frozen samples from 2003-2007 epidemiology studies were analyzed
- **Status & Results***
 - o Draft report undergoing peer review
 - o 24 and 48 hr results were limited, conflicting and difficult to interpret
 - o 12 and 24 month samples were degraded
 - o Reanalyzed archived samples were degraded
 - o **Conclusion:** Archived samples should not be used for establishing health relationships with new indicators (P22)
 - o No recommendation on holding time due to inconclusive results, but limited data suggests that refrigerated samples should not be held for 24 hours or longer [Note: 6 hours used in NEEAR studies].

* Subject to change, based upon peer review comments and revision

7



Fecal Source Characterization

- Evaluate bovine and human host-specific markers as PCR assays for indicators of cattle or human fecal pollution.
 - o Evaluate regional differences, seasonality, fate and transport, relationships with other fecal indicators and methods.
- Multiple case studies are being conducted at fresh and marine water sites to evaluate both human specific and animal markers at known animal and human sources of contamination.
 - o Efforts include mesocosm fate and transport studies and surveys of national rivers and streams.
- Identify genetic sequences useful in chicken and gull fecal sources and evaluate the assays for sensitivity and specificity.



Quantitative Microbial Risk Assessment (QMRA) for Agricultural Animals

- EPA is conducting a QMRA to estimate illness at a freshwater beach impacted by agricultural animal sources of fecal contamination.
- The risk assessment is based on microbes that are pathogenic to humans (e.g., *E. coli* O157:H7, *Cryptosporidium*, etc.) and come from ag. animal sources.
- Evaluated the risk assessment approach in comparison to the NEEAR freshwater epi study results – “anchoring”
- Conducted field studies with simulated rainfall and controlled application of fecal material from cattle, poultry and swine
- Surveyed the scientific literature for information on zoonotic pathogen occurrence, distribution, prevalence, infectivity, and other parameters for use in the risk assessment.

9



Quantitative Microbial Risk Assessment (QMRA) for Agricultural Animals [cont.]

- Risk assessment is currently underway
- Incorporating the results from targeted field studies into the exposure assessment models
- Results should help inform on the relative nature of human health risks from various fecal sources

10



Enhanced Sanitary Investigation Tool

- Enhanced sanitary investigation instrument was developed that captures information sufficient to support the conduct of a QMRA
- The form was tested at EPA epi study sites in 2009.

11



Validation of Analytical Methods for Ambient Water Testing

- EPA completed a single-laboratory validation study of EPA's quantitative polymerase chain reaction (qPCR) procedures for the quantitative detection of enterococci (Method A) and Bacteroidales (Method B), in fresh and marine waters
- The purpose of the study was to:
 - optimize the methods (to further refine)
 - assess method performance in the single laboratory environment across multiple matrices
 - facilitate future modification of the two methods
 - provide a basis for a multi(ple) laboratory validation study
 - develop draft quantitative quality control (QC) acceptance criteria
- The draft methods are published (Method A: Enterococci EPA-821-R-10-004 and Method B: Bacteroidales EPA-822-R-10-003) on the EPA web site at:
 - <http://www.epa.gov/waterscience/methods/method/biological/>
- A multi-lab validation study for the two methods is underway for marine waters and the freshwater study will begin next spring

12



Evaluation of Indicator/Method Combinations

- EPA is evaluating indicator/method combinations for use in new or revised criteria
- Performance criteria for important features being evaluated include:
 - indicator/illness health relationship established
 - limit of detection
 - sensitivity
 - specificity
 - precision
 - percent false positives and false negatives
- Also evaluating qPCR and culture methods qualitatively to determine, for implementation purposes, appropriateness for each Clean Water Act program.

13



Indicators/Methods – Wastewater

- EPA has determined, based on the preliminary results of the studies in P8 and P18 that a new or revised wastewater test method is not necessary.
- The preliminary results from the P8 study indicate that the Enterococci qPCR method measures DNA levels in both wastewater and receiving ambient waters.
- The preliminary results from the P18 study indicate that existing culture methods approved for wastewater may be sufficient.
- Therefore, based on the results available at this time, a new wastewater method is not needed.

14



Other Indicator/Method Efforts

- Developing Approaches to Bring Additional Indicator/Methods into Criteria
 - Establish scientifically defensible “equivalency” of indicator/methods with an unknown health relationship to indicator/methods with an established health relationship.

15



Monitoring & Modeling

Monitoring:

- EPA is preparing a report that describes the temporal and spatial variation associated with water sampling.
 - o Considerations for developing sampling plans for beach monitoring
 - Inland vs. coastal
 - Where, when and how to sample

Modeling:

- Refinement of Virtual Beach Model Builder (VBMB)
 - o Collected freshwater and marine fecal indicator and environmental data
 - o Builds models using culture and qPCR data
 - o Report titled “*Predictive Modeling at Beaches-Volume II: Predictive Tools for Beach Notification*,” on results and Virtual Beach software, is undergoing external peer review
- Catalog and evaluate existing information on models and other tools to predict water quality at beaches and discuss protocols for model development. Predictive Models:
 - o Provide results in a “timely manner”
 - o Supplement to water sampling, not replacement

16



Inland Waters

- EPA is preparing a report to support its evaluation of applicability of NEEAR Great Lakes data to inland waters
 - Summarizes work of EPA and WERF related to assessing similarities and differences in inland waters, including:
 - Input from experts during February 2009 WERF Experts Inland Waters Workshop
 - Literature review of occurrence, persistence, fate & transport of indicators and pathogens in inland v. coastal settings
 - Comparison of Culture and qPCR methods
 - Method performance in inland fresh waters

17



Resources

- rec_criteria@epa.gov
- <http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/recreation/index.cfm>
- http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/recreation/oct2010_index.cfm



THANK YOU

