

EPA's Critical Path Science Plan for the Development of Recreational Water Quality Criteria

Mark Rodgers, EPA/ORD



Slide Acknowledgements

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Recreational water quality criteria development

- Oct. 2000 Beaches Environmental Assessment and Coastal Health Act
 - Requires:
 - EPA to conduct studies on pathogens/human health and:
 - Publish new/revised recreational water quality criteria for pathogens and indicators based on these studies.

EPA's Critical Path Science Plan for New/Revised Recreational Water Criteria

- Describes research and science for establishing the scientific foundation for new/revised criteria
- Is an integrated approach to answering key science questions for scientifically sound criteria
- <http://www.epa.gov/waterscience/criteria/recreation/plan/index.html>

Goals of the Science Plan Research

- Assess Human Health Risk
- Develop Indicators
- Develop Methods
- Extrapolate Research Results

Key Research Questions (1)

- *What is the risk to human health from swimming in water contaminated with human fecal matter as compared to swimming in water contaminated with non-human fecal matter?*
 - **Risks from Human Sources of Fecal Contamination**
 - **Risks from Non-Human Sources of Fecal Contamination**

Key Research Questions (2)

- *How well do culture and molecular methods for various indicators (singly or in combination) correlate with swimming-related illnesses?*
 - **Develop, Evaluate and Validate Indicators and Methods**
 - **Assess Linkages between Indicators and Methods**
 - **Characterize Temporal and Spatial Variability in Measurements**

Key Research Questions (3)

- *Are the indicators, methods and models suitable for use in different types of waters and for different CWA programs?*
 - **Assess Variability in Diverse Geographic and Aquatic Conditions**
 - **Assess Methods Suitability to Different CWA Purposes**
 - **Develop, Evaluate and Validate Predictive Models and Tools**

Categories of Research Activities

- Epi Studies and/or QMRA
- Indicators, Methods
- Fate & Transport Studies
- Predictive Modeling
- Site Characterization Studies
- Research to Support Extrapolation to Inland Waters

Epidemiological Studies

- 2002-2004 Freshwater NEEAR Studies at four Great Lakes Beaches
- 2005 Marine NEEAR Study in Biloxi, MS (partial study)
- 2007 Marine NEEAR Studies in Goddard, RI and Fairhope, AL
- 2007/2008 Supported marine studies with SCCWRP in Southern CA at Avalon and Doheny Beaches
- 2009 Planned Studies:
 - Beach in tropical region
 - Marine beach impacted by urban runoff in a temperate region
 - Technical support to studies by SCCWRP
- **More info from Tim Wade later**

Quantitative Microbial Risk Assessment (QMRA)

- Determine data components for QMRA
 - Currently- norovirus, *Campylobacter*, *Cryptosporidium*
 - Research gap- proportion of infectious strains
 - Best models? Most critical factors?

Quantitative Microbial Risk Assessment (QMRA)

- Perform site characterization work to select appropriate location.
- Conduct QMRA to estimate illness at a freshwater location primarily impacted by agricultural animal sources

Indicators/Methods Development and Validation

- Evaluate multiple indicator/method combinations
 - Enterococci qPCR and culture, *Bacteriodes* (general and human specific) qPCR, *E.coli* qPCR, *Clostridium perfringens*, coliphage, others.
- Study effects of sampling holding time, storage and preservation
 - 4°C storage for 1, 24, 48 hrs- analyzing data now
 - -80°C storage – no obvious effect

More info from Richard Haugland later

Fate and Transport of Indicators and Pathogens

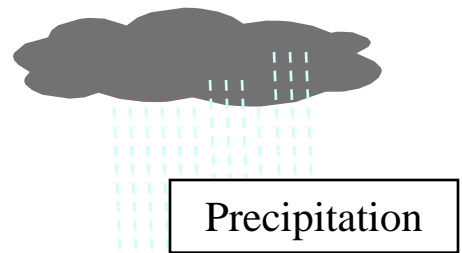
- Relationship between stability of culture and qPCR signal
- Relationship between stability of qPCR and indicators and pathogens
 - Enterococci qPCR and culture, *Bacteriodes* (human specific) qPCR, *E.coli*, *C. perfringens*, F-specific coliphage, others.
 - *Cryptosporidium* via enumeration and tissue culture
 - Enteroviruses via integrated cell culture/PCR

Indicators/Methods Development and Validation

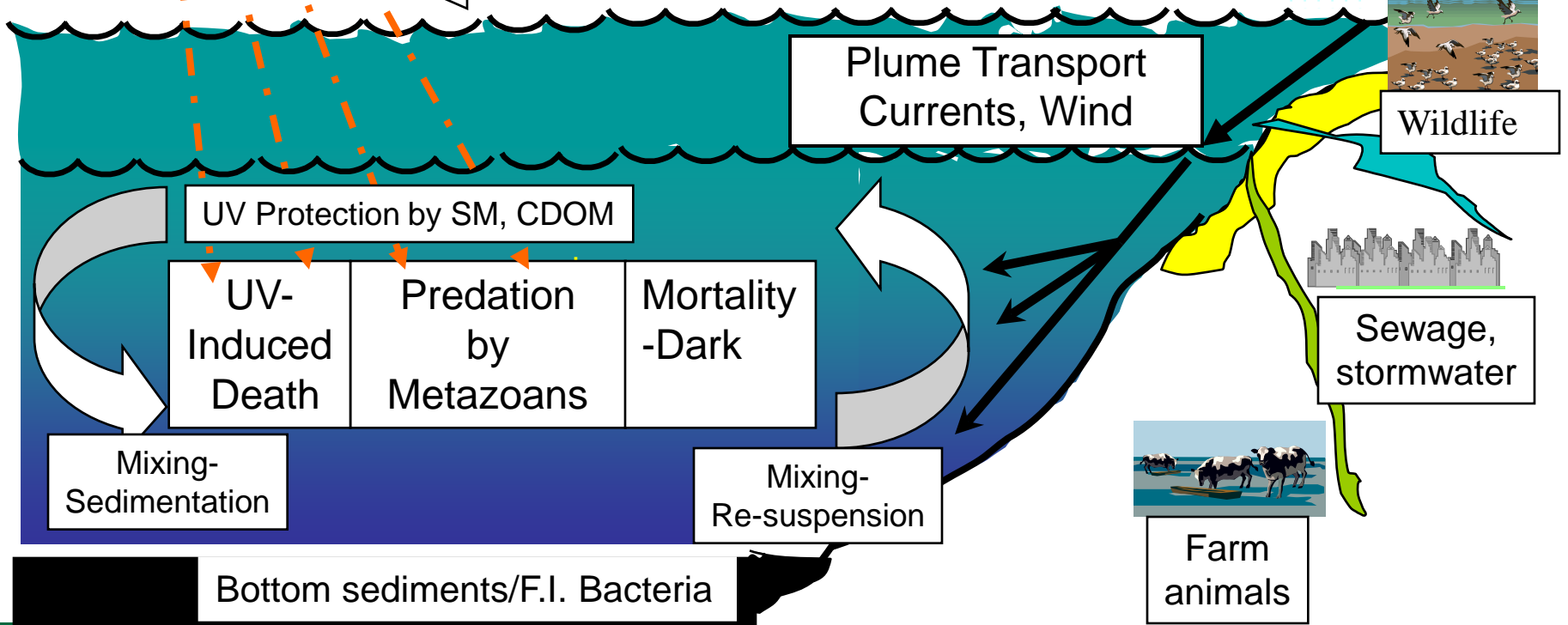
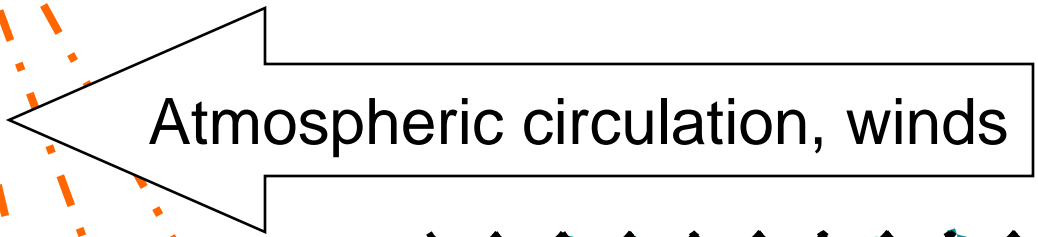
- Evaluate suitability of individual indicator/ method combos for different CWA purposes
-
- Develop and evaluate genetic markers- **Orin Shanks**
 - Human
 - Bovine
- Identify genetic sequences for avian markers- **Jorge Santo Domingo**
 - Chicken
 - Seagull



Sources (Point and Non-Point), Fate and Transport of Pathogens in Land and Water



Rapid changes occur in pathogen exposure!



Predictive Modeling

- Develop and pilot test software for beach-specific predictive models
 - **Virtual Beach Model Builder**
 - Software package that facilitates developing multiple linear regression (MLR) models for pathogen indicator prediction
 - **Beach Advisor**
 - Software package provides user friendly beach advisory decision support for non technical users

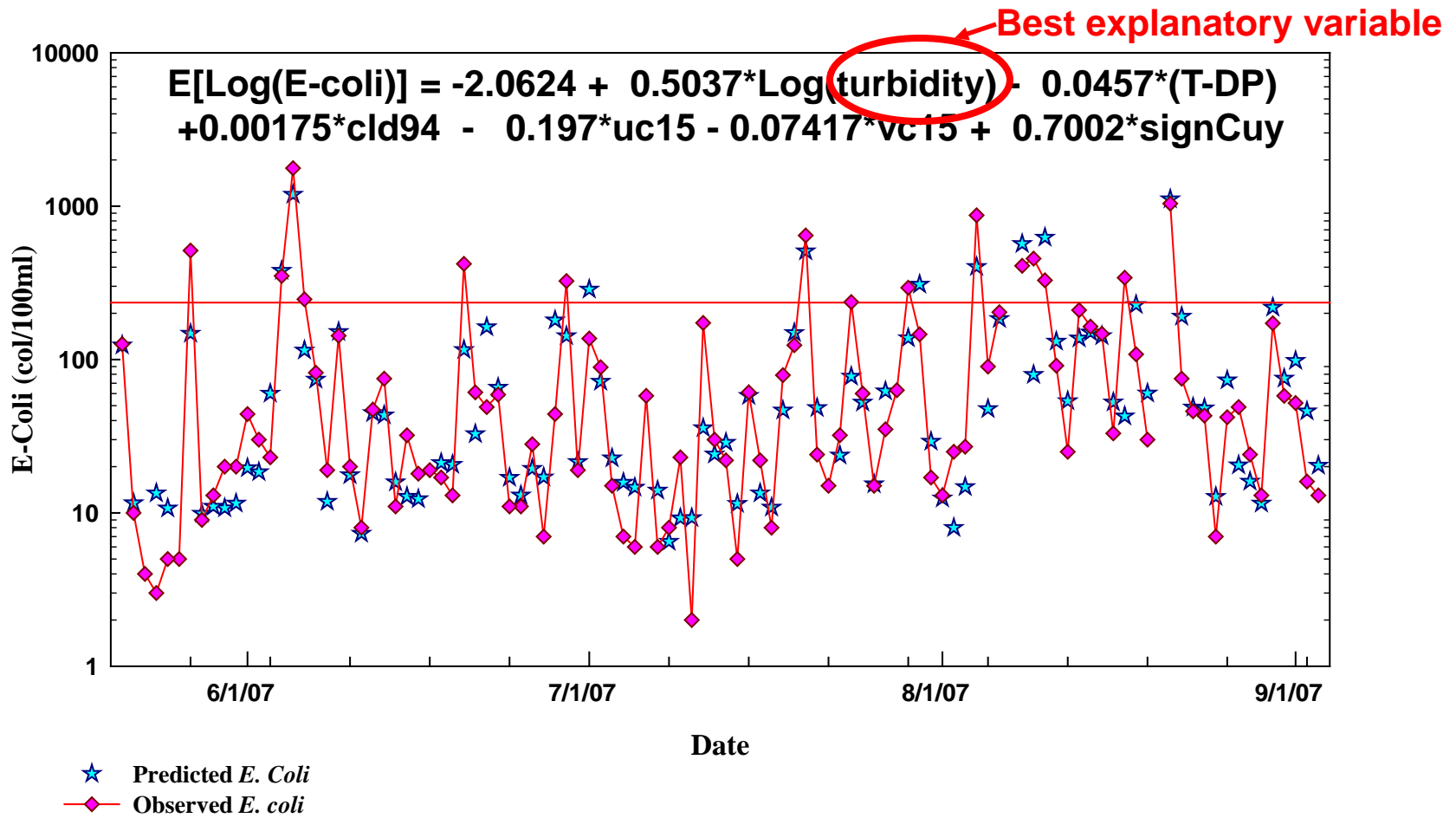
Nowcasts and forecasts

- **Nowcasts** are predictions of current, but yet unknown, microbial levels based on real-time explanatory variables
- **Forecasts** are predictions of future (24- to 48- h in advance) microbial levels using forecasted explanatory variables

Virtual Beach: nowcasting & forecasting beach microbiology

- **Multiple linear regression (MLR) models**, using explanatory variables
 - Such as turbidity, air temperature, cloud cover, and rainfall
 - Often perform much better than use of day-old results from cultures of beach microbial samples
 - To improve the development and performance of MLR models, EPA has developed Virtual Beach Adviser software

MLR model created using Virtual Beach Model Builder- Nowcast vs. observed *E. coli* at a Lake Erie beach



Predictive Modeling

- Research questions:
 - Why do certain variables work better than others?
 - How to best widen the time event window to capture transport of pathogens after storm events?
 - How to make most accurate Forecasts?
 - Can we link Virtual Beach with other types of models?

Site Characterization

- Data collection and source characterization to aid in site selection for 2009 epi studies
- Evaluate quantitative sanitary investigation methods
 - Still working to define what this looks like
- Pilot sanitary survey in Great Lakes
 - Developed a survey instrument and manual

Application to Inland Waters

- Literature reviews to determine differences in inland waters, especially in flowing waters
 - Fate and behavior of pathogens and indicators
 - Microbial Ecology and Persistence
 - Indicator Performance
- Support and participate in WERF's Inland Waters Experts Workshop- receive input for future work
- Analyze samples from EPA's National Rivers & Streams Survey for additional indicators by molecular methods
 - 2200 sample locations
 - GIS characterizations underway now
 - POTW impacted and pristine headwaters

Criteria Development Plan

- Ongoing scientific research (July 2007 – December 2010)



Data analysis

Peer-review

Public comment

- Publish criteria document (or publish notice of availability) in the Federal Register (December 2012).

Outreach

- Stakeholders meeting and Methods Validation meeting (2008)
- Attending conferences (GLBA, WEF)
- National Beach Conference and Research Forum (2009)
- Planned stakeholder workshops (2009, 2010, 2011)
- Experts scientific workshop (2011)

For More Information

- EPA's Beach and Rec Criteria Web Pages
 - www.epa.gov/beaches
 - BEACH Act
 - Grants information
 - Local beach information
 - www.epa.gov/waterscience/criteria/humanhealth/microbial/#wqs
 - Bacteria Rule
 - www.epa.gov/waterscience/criteria/recreation
 - Experts Scientific Workshop Report and Executive Summary
 - Critical Path Science Plan
 - Criteria Development Plan & Schedule