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NEARSHORE AND BEACH
FORECAST OF PUBLIC HEALTH
USING QMRA

Focus of This Work

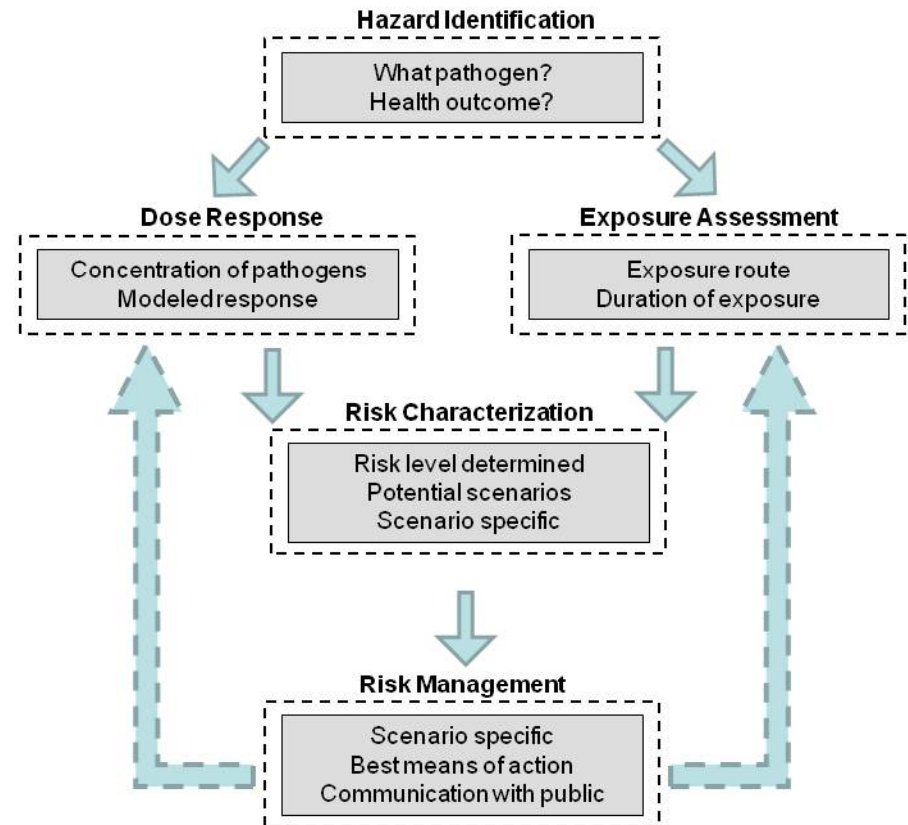
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- Dynamic QMRA for Great Lakes beaches
- QMRA is scenario specific
 - ▣ Outfall with pathogens
 - ▣ Hydrodynamics in that region
 - Transports pathogens to beach
 - ▣ Only examining primary exposure
 - Bathing/swimming/playing in the water
- Build risk tool for beach managers.

Introduction to the Proposed Work

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- What is QMRA?
 - ▣ Quantitative Microbial Risk Assessment
- Gather information and model risk(s) posed by pathogens
 - ▣ Infection, illness or death



NAS Risk Paradigm

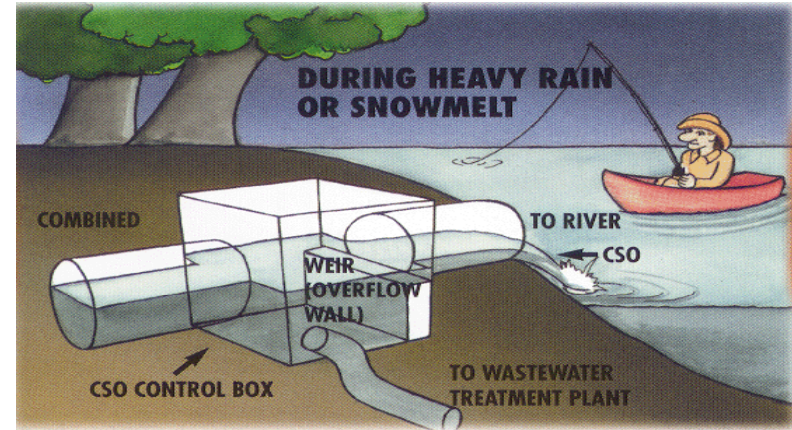
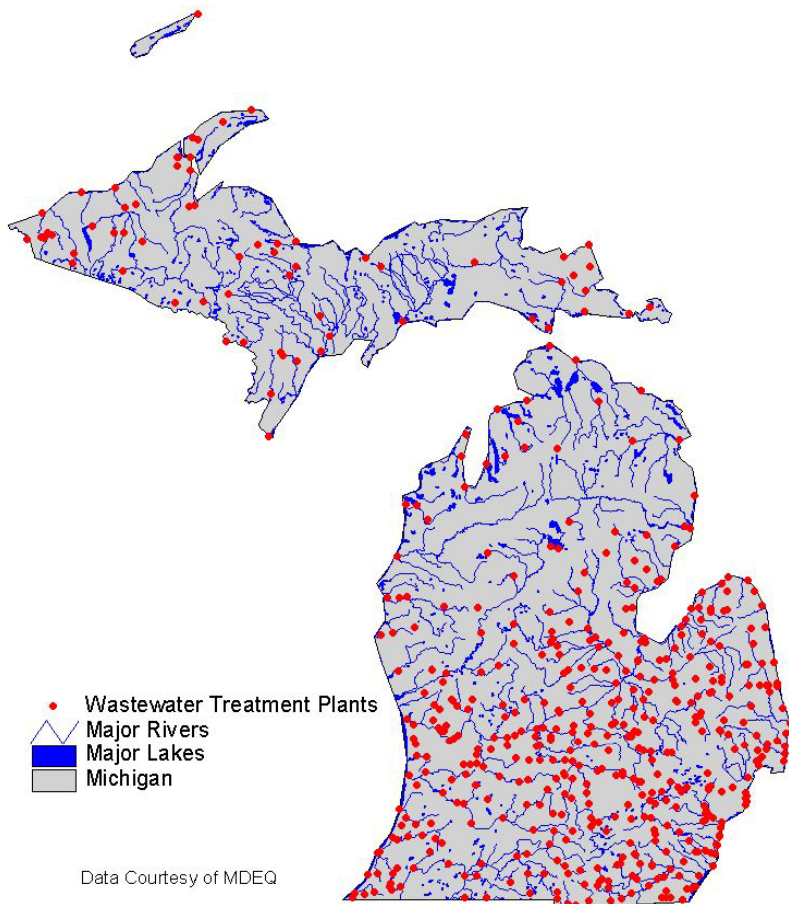
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- Hazard Identification
 - ▣ Types of pathogens, resulting diseases
- Exposure Assessment
 - ▣ Monitoring data, advanced and current models
- Dose Response Assessment
 - ▣ Mathematical representation of effect of dose on hosts
- Risk Characterization/Management
 - ▣ Risk level and decisions based on this estimate

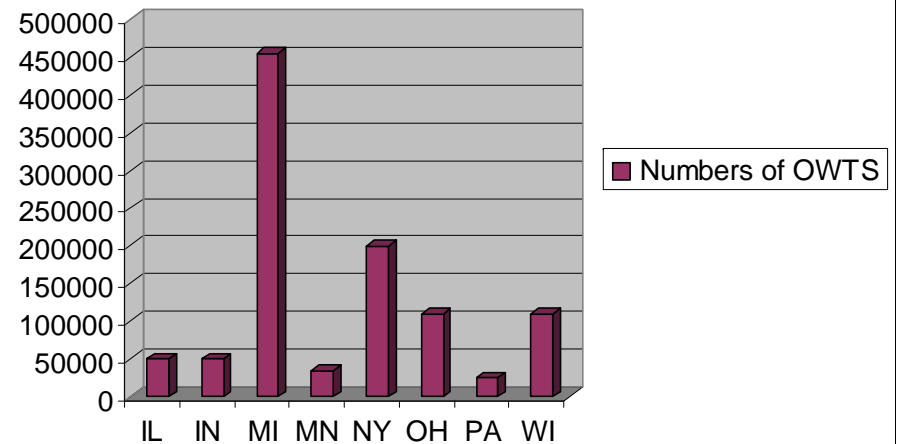
Hazard Identification

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Wastewater Treatment Plants vs. Major Rivers and Lakes



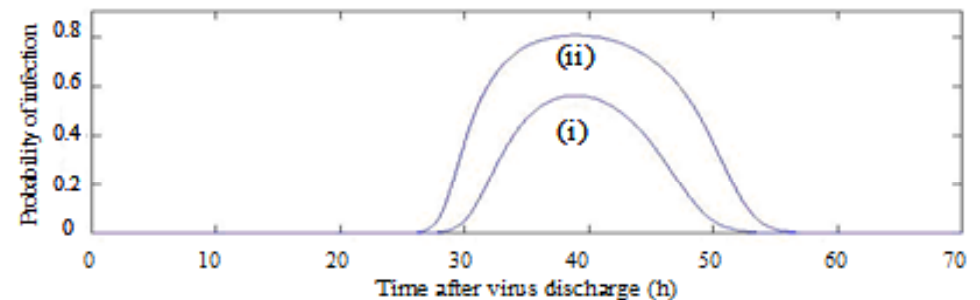
On site Wastewater Systems in the Great Lakes



Exposure Assessment

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- Gives predictive power to QMRA
- Determination of contamination level
 - At a specific location
 - Neighboring locations
 - Likely contamination at a future time point
- Determination of dose
 - Required for the quantitative in QMRA
 - Informs likely risk posed
- Point estimates vs. dynamic model
 - Difficulty increase
 - Accuracy fluctuation
 - Predictive power



Dose Response

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□ Mathematical representation

- Function which describes
- Likely response based on a dose of pathogens

□ Depends on

- Pathogen
- Outcome (*i.e.* infection, death)
- Available data
 - Typically animal model data

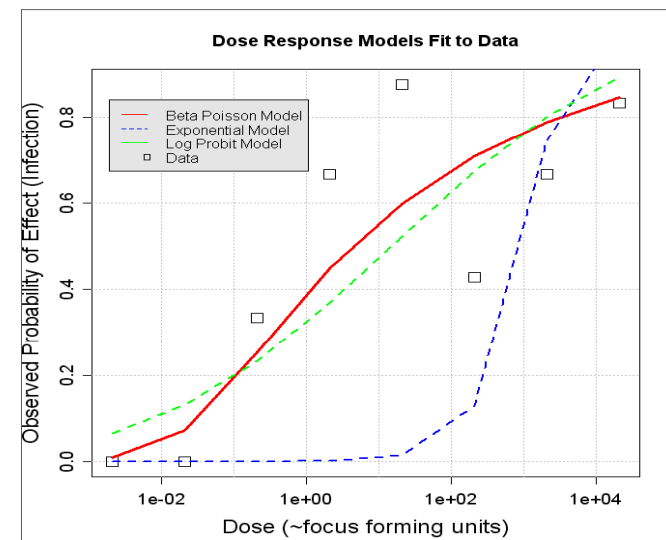
□ Two main models

Exponential:

$$P(R) = 1 - \exp(-k \cdot \text{dose})$$

Beta Poisson:

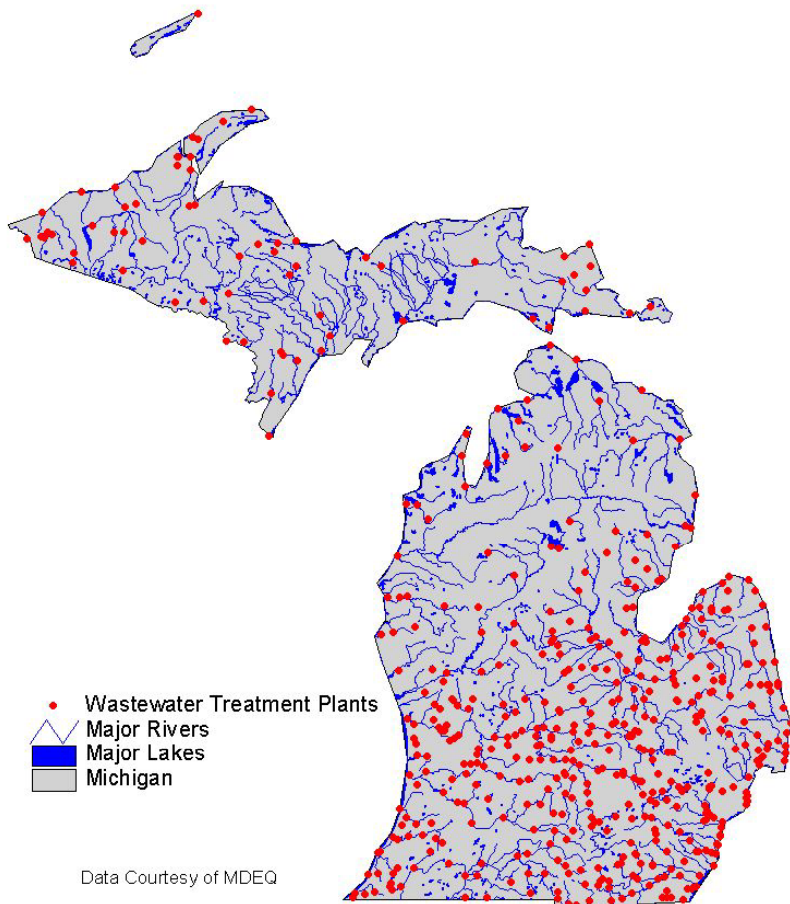
$$P(R) = 1 - \left[1 + \frac{\text{dose}}{N_{50}} \cdot (2^{1/\alpha} - 1) \right]^{-\alpha}$$



Why QMRA?

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Wastewater Treatment Plants
vs.
Major Rivers and Lakes

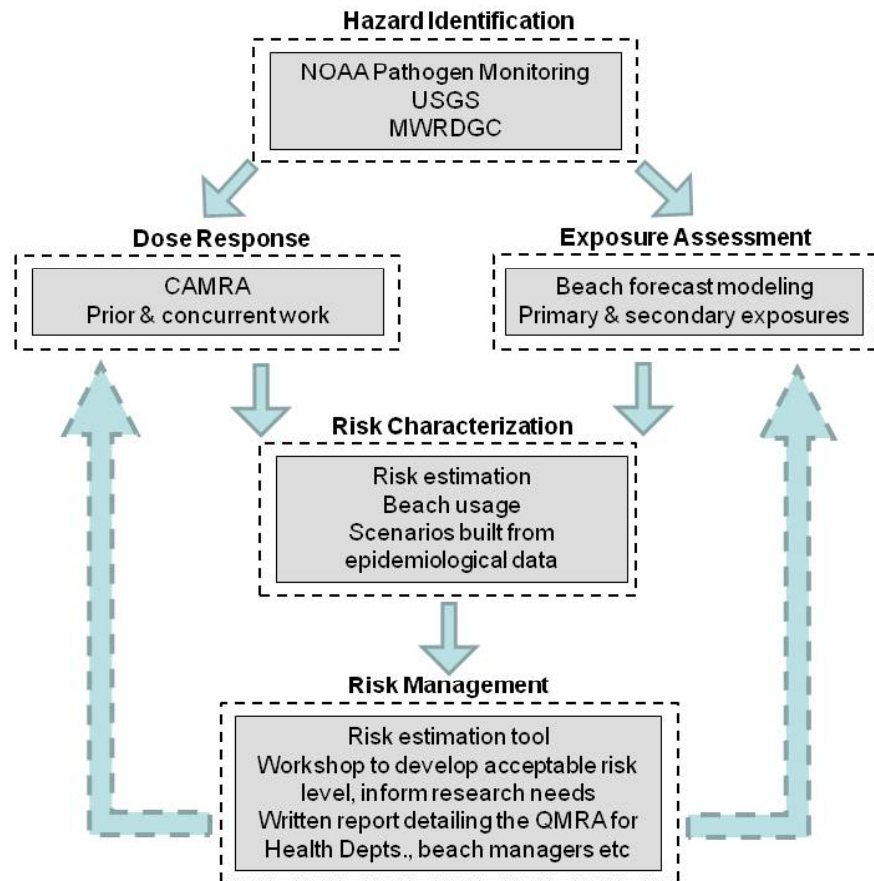


- Gives more information than standard monitoring
 - ▣ Can directly deal with uncertainty in monitoring
- Potential for prediction
 - ▣ Uncertainties of transport and occurrence can be handled directly in the QMRA
- Framework once demonstrated
 - ▣ Has potential for very informative risk estimates

QMRA

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- Entire framework will be used
 - ▣ Not researched in this work
 - Bank of dose response models
 - Hazards understood already
- QMRA specific to this project
- Sources of information



Forecasting

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- Likely occurrence of an event in the future
 - e.g. weather
- Forecasting is possible for
 - Expected concentrations
 - Expected impact of contamination events
 - **Expected risks**
- Useful for community protection

Forecasting Models

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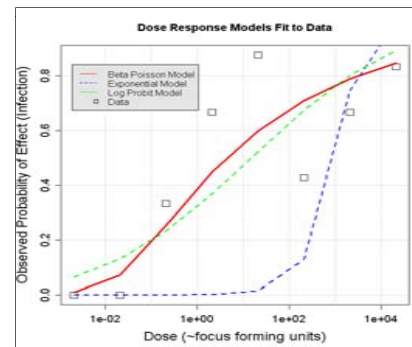
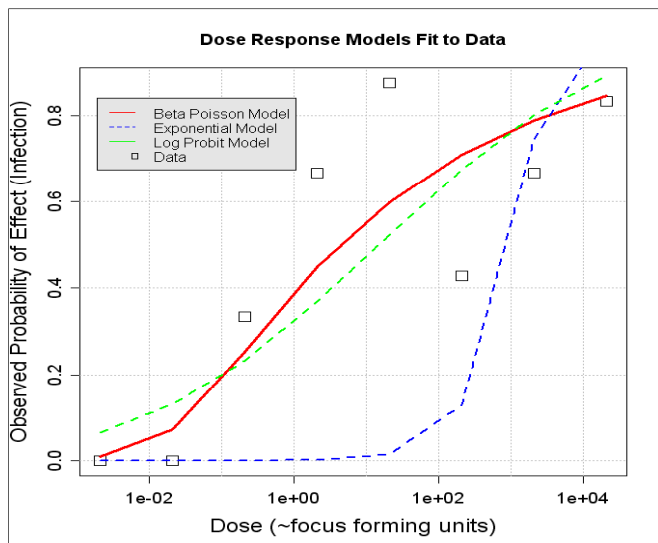
- Complexity
 - ▣ Depends on what is being modeled
 - More complex scenario typically requires more complex models
 - ▣ However higher complexity \neq higher accuracy
 - For all instances
 - Sometimes simplicity rules the day
- Predictive power

Forecasting Using QMRA

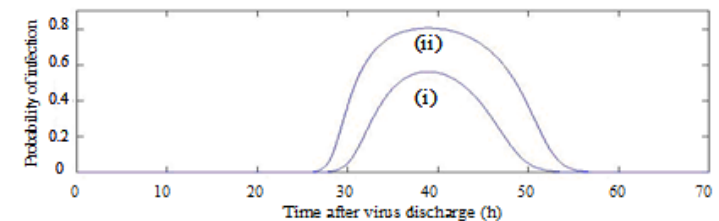
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- QMRA typically viewed as static
- One pathogen one route one risk
- Good for point estimates

- Dynamic QMRA
- More realistic



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Pathogen Monitoring

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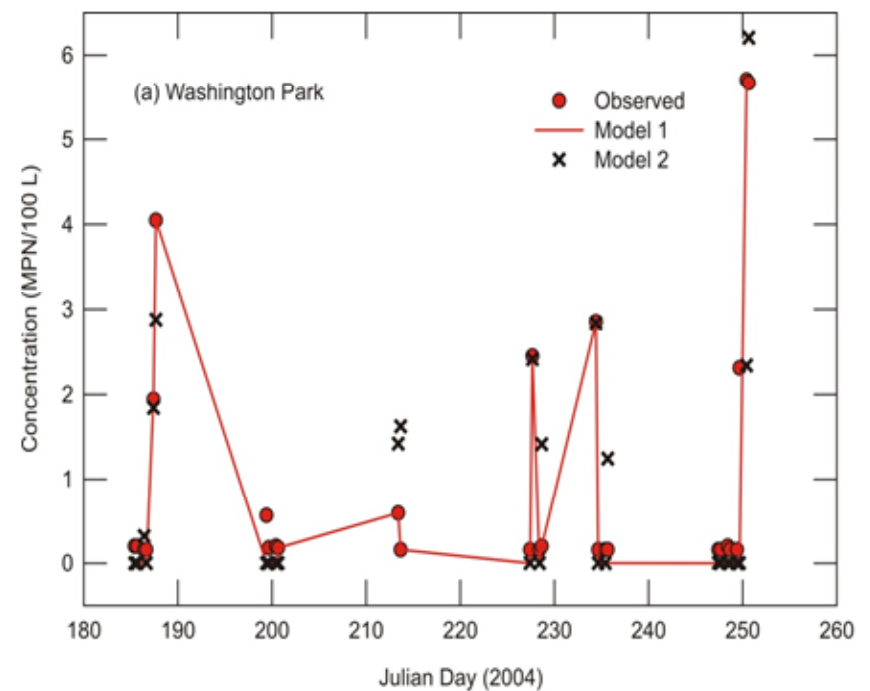
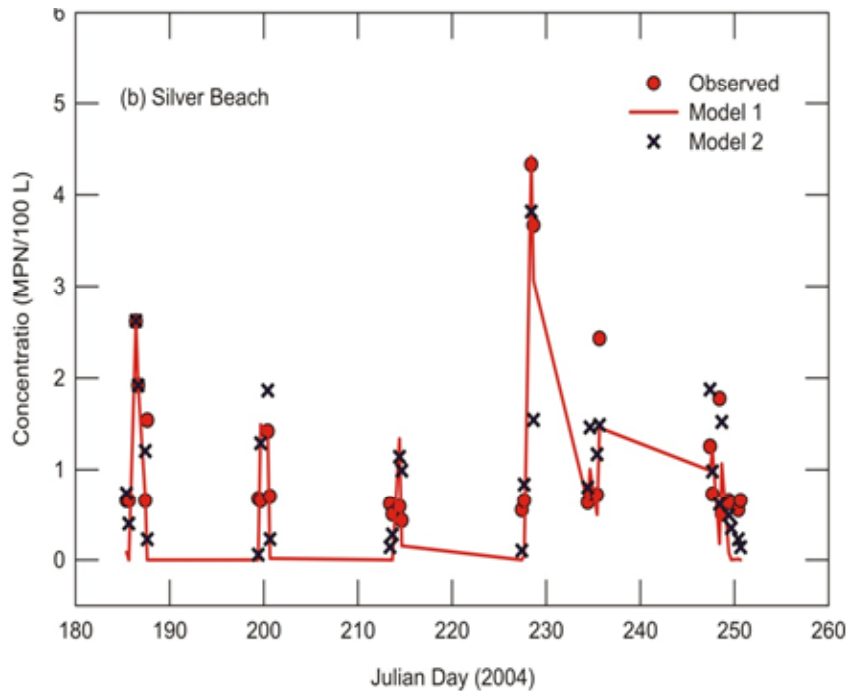
- Test water near the beach
 - Monitoring allows for an understanding of contamination level at one location
 - Can determine a risk
 - Not very informative, single point, not well extrapolated



Probabilistic Transport Models

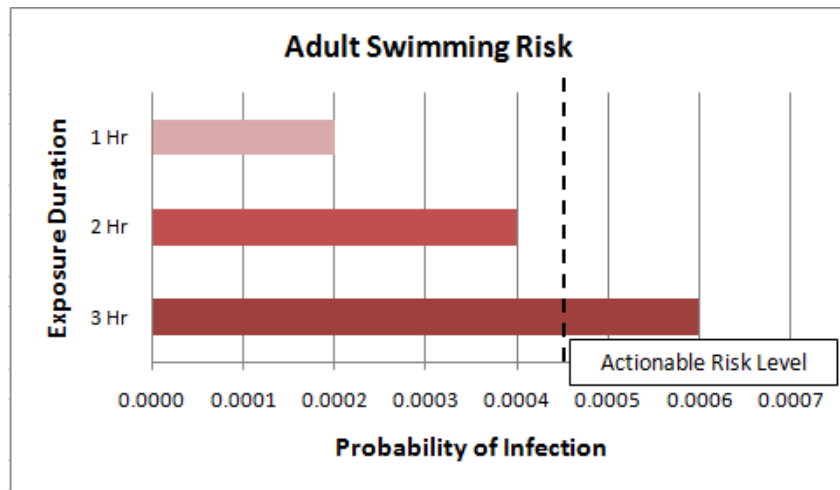
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- Predicts contamination level
 - ▣ Based on current weather and lake conditions
 - ▣ Not widespread
 - ▣ Simple mathematics not simple to build



Proposed Risk Tool

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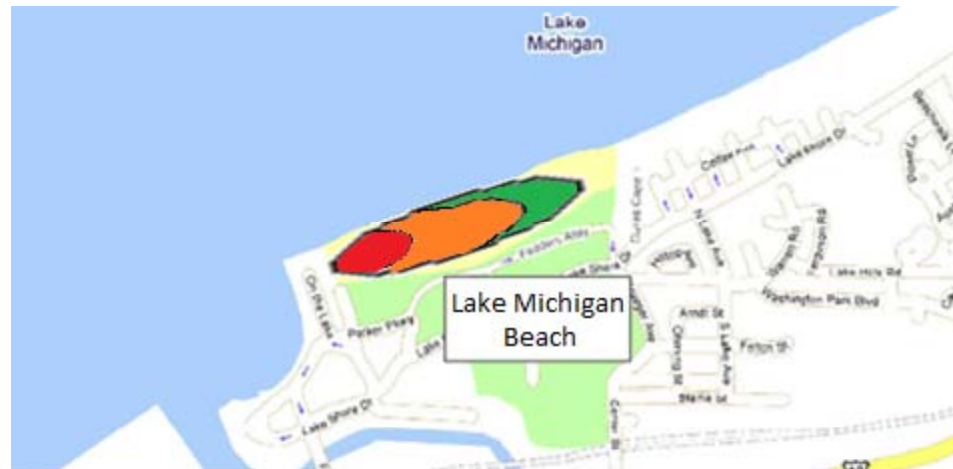


- Excel spreadsheet
 - ▣ Easy to use
 - ▣ Portable
- Uses probabilistic transport models
 - ▣ Determines exposure level
- Catalogue of dose response models
 - ▣ Develop risk levels

Future Directions

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- Advanced exposure piece
 - ▣ Understand dynamic effects of beach sand
- Potential for more developed assessment tool
 - ▣ Develop a “risk map” of the beach



Eventual Requested Assistance

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- How useful is this tool?
- Transport models can be developed given collaborative partnerships
- What future directions would be of interest to you?
- What else would be of interest for a rapid risk assessment tool?

Acknowledgements

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Great Lakes Restoration Initiative

Center for Advancing Microbial Risk Assessment



Joan B. Rose PhD.

Joanna M. Pope PhD.

Brian M. Panzl